ELECTRONIC CAMERA

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an electronic camera, particularly to a thin and light electronic camera capable of mounting an optical zoom having high magnification. Further, the present invention relates to an optical zoom mechanism and camera having a power mechanism such as a cam or a lead screw which moves an optical system for zooming and an optical zoom mechanism having a rate reducing device provided to an interlocking system for a motor which drives the power mechanism. The present invention relates to a cam apparatus which converts a rotational motion to a linear motion through a cam groove and to a camera zooming by moving an optical system using the cam apparatus. Further, the present invention relates to an image capturing apparatus provided to an optical instrument such as an electronic camera and to a camera.

Description of the Related Art

An electronic camera having an image capturing element such as a CCD and recording an image in digital form does not require to develop or to print like a conventional camera using a photographic film. A captured image can be seen instantly with this type of camera. In addition, an image capturing element such as CCD is smaller than a conventional photographic film, despite a number of pixels for an element increases year after year whereby a camera body itself can be advantageously made smaller.

Therefore, a camera having such a strength and a thickness as capable of shoving in a breast pocket of a dress shirt or in a hip pocket of jeans and such a lightness as make one no sense of discomfort when it is put in these places or a handbag, and yet having a zoom mechanism of high magnification is desired to appear.

However, a type of camera wherein a photographic lens is protruded from a camera main body

such as a camera, in which a conventional photographic film is used, is difficult to define a thickness of the camera thinner than a definite thickness because of a zooming mechanism and a thickness of a lens, even if a sinking barrel type is adopted, wherein lenses are placed in a main body except when photographing operation.

The zoom lens is made so as to vary a focus of a whole lens by moving along a direction of an optical axis a lens group or lens groups more than one of a plurality of lens groups disposed on a same optical axis. As a technique for controlling the movement of the lens group when zooming, it is popularly practiced that a cam plate which engages the moving lens group is provided and the lens group is moved while more than two lens groups are correlated as lens groups are moved in dependence upon a shape of a cam by rotating the cam plate with a hand or a motor.

As a conventional cam mechanism of this type, a cylinder shaped cam, hereinafter referred to as a ring cam, is coaxially provided around an outer periphery of a lens barrel and a lens group is moved by rotating the cam ring around the axis as the lens group is engaged with the cam ring. Besides a zooming technique by a cam mechanism, there is another technique in which a lead screw is provided along the optical axis of a lens barrel and a lens group engaged with the lead screw is moved along the optical axis by rotating the lead screw around the axis.

Accordingly, as mentioned above, in case a lens is disposed in front of a camera main body and a cam ring is provided around an outer periphery of a lens barrel, even if a protruded portion is avoided by sinking all the lenses into the camera main body when the power is off, a thickness of a camera can not be made thinner than a height of the cam ring or a total thickness of an added thickness of all plural lenses in a lens group along the optical axis. Further, since a zoom lens uses plural groups of lenses, more necessary lenses increase as magnification becomes higher so that a total thickness of these lenses makes a thickness of camera main body along the optical axis considerably thick, which results in difficulty of making the camera thin.

When the cam ring is disposed around the outer periphery of the lens barrel, a length in diameter direction of the lens becomes large, which results in enlarging the whole apparatus so

that an obstacle to designing a thin camera arises. However, a camera withheld from thickening owing to high magnification of a camera appears. For example, in a camera of sinking barrel type in which a plurality of lens groups are placed in the camera body, a structure of the camera is such that when protruded lens groups is stored by switching off the main power source, a lens group A of a middle portion among a plurality of lens groups which move within the limits of the optical axis is transferred beyond the limits of the optical axis to be stored in the camera main body and a lens group of an object side is stored in the camera main body within the limits of the optical axis. Thus, a thickness along the direction of the optical axis can be reduced thin by transferring the lens group A of a middle portion beyond the limits of the optical axis.

However, since a lens group of a camera in which a lens group A of a middle portion is transferred beyond the limits of the optical axis is transferred beyond the limits of the optical axis, a structure for ensuring an accuracy of the optical system becomes complicated and a number of parts increases for transferring a lens group beyond the limits of the optical axis, which leads to additional cost. In a type of camera in which a middle lens group or a lens barrel is sunk into a camera main body by putting the power source off, a photo opportunity is lost because a definite time is necessary until the camera is ready to take a photograph for protruding a group of lenses when a main power source is on.

In a camera in which a lead screw is disposed along an optical axis of a lens barrel, it is possible to make the camera smaller since a space in the vicinity of the lens barrel decreases by reducing parts such as a cam ring as compared to a camera using a cam mechanism.

However, a camera of this type is usually provided with a plurality of lens groups in a direction parallel to a display unit which display a photographic image and with a reflecting board or a prism for converting the direction of the optical axis at an angle of 90 degrees between a lens and a lens behind a first lens at a side of an object, whereby an object is photographed in a direction orthogonal to the display panel of the display unit, so that a number of parts is reduced to attain downsizing. On the other hand, new parts such as the reflecting board or the prism increase and the structure becomes complicated, which leads to a weight increase and cost increase of the

camera, so that the camera can not be made so remarkably thinner or smaller as compared to a camera with a cam mechanism.

In order to solve such problems accompanied by making a camera thin and high magnification, an art described in Japanese patent publication No. 2931907 is proposed. According to the proposed art, an image capturing unit containing a photographic lens and an image capturing element, and a camera main body provided with a display unit such as LCD are mounted rotatably whereby the image capturing unit is rotated in a direction of photographing with respect to the camera main body at a time of photographing and the image capturing unit is stored in the camera main body at a time of non photographing by rotation. Thus, by rotating the image capturing unit with respect to the camera main body, the image capturing unit can be stored in a direction parallel to the display unit so that a thickness of in a direction orthogonal to the display unit of the camera main body can be made thin.

Though there is no description concerning a zoom mechanism in such a thin body type camera, Japanese laid open patent publication No. JP1992-158632 (Fig.2) or Japanese laid open patent publication No. JP1995-23259 (Fig.2), for example, discloses that a whole length of an optical system is stored in a camera as a direction of an optical axis of the optical system is coincided with a longitudinal direction or a lateral direction of the camera main body. That is, in a camera disclosed on Japanese laid-open patent publication No. JP1992-158632, a photographic window is disposed on a down side face of a camera main body in which an openable upper lid is provided to a display unit like a type of a pocket book, an incident light from the photographic window is reflected with a reflecting mirror provided at an angle of 45 degrees to enter into a lens system whose optical system is arranged in a longitudinal direction or a lateral direction of the camera main body and further the light is entered into an image capturing element disposed on a side of the photographic window by reflecting with a reflecting mirror disposed at an angle of 45 degrees. In a camera disclosed on Japanese laid-open patent publication No. JP1995-23259, a display unit is disposed on one face of a pocket book type main body and a photographic lens is provided in a main body in which a photographic window is disposed in a direction of the thickness as an optical axis is defined in a direction parallel to a longitudinal direction of the main

body.

However, as a camera disclosed on Japanese laid-open patent publication No. JP1992-158632 has a display unit on the backside of a photographic window for a photographic optical system; the display unit is visible when the photographic system is targeted to an object at an eye-level. Nevertheless, when a photographer wants to photograph him/herself, an object near land surface or over heads of a lot of people, he/she needs to guess a photographing range. Further, as a camera disclosed on Japanese laid-open patent publication No. JP1995-23259 has a display unit whose plane coincides with a direction of the optical axis of the photographic optical system, it is convenient when the camera is targeted to an object under or upper than eye-level but it is difficult to confirm a photographing range with the display unit.

Many recent cameras have a viewfinder having a zooming function or a flash unit besides a zooming function of a photographic lens. Zooming is performed by moving a zoom lens with a power mechanism with a motor-driven cam or lead screw.

For example, as a zooming structure of a photographic lens, a cylindrical cam for zooming is disposed at a lateral position of a photographic lens and a cam pin of the photographic lens is inserted into a cam groove of the cam for zooming so as to drive in conjunction therewith.

Further, a zoom motor is disposed forward or backward to the cam for zooming and rate reducing device is dispose between the motor and the cam so as to reduce a motor out put with the rate reducing device, transfer to the cam and rotate the cam.

The rate reducing device has a lot of rate reducing gears besides a first rate reducing gear which engages a motor pinion. A last rate reducing gear engages a gear provided to the came for zooming.

Various kinds of cam apparatuses are used for such zooming function (see Japanese laid-open patent publication No. JP2002-72043).

Fig. **45** is a perspective illustration of a driving mechanism for zooming **10**. Though the drawing shows a first lens group **11** and a second lens group **12**, the driving mechanism has a third lens group besides them and zooming is actually performed with the first, third lens groups.

The driving mechanism for zooming **10** has a boss (a bearing portion) **11b** provided at a lens frame **11a** of the first lens group **11** and a guide shaft **13** pierced to a boss **12b** (a bearing portion) provided at a lens frame **12a** of the second lens group **12** so as to move the first and the second lens group **11, 12** as sliding through the guide shaft **13**.

Each of lens frames **11a, 12a** has a hole portion (unshown) at the position opposite to boss **11b** or **12b**, through which the slide shaft **14** is pierced whereby the first and the second lens group **11,12** is prevented to rotate. The above mentioned guide shaft **13** and the slide shaft **14** fixed so that one end is fixed to a front fixing frame **15** and another end is fixed to a rear fixing frame **16**.

Meanwhile, the above mentioned boss **11b** has a protruded cam pin (a cam groove inserting member) **11c** and boss **12b** a protruded cam pin (a cam groove inserting member) **12c**, which are contacted while pressing to a first cam plane **17a** and a second cam plane **17b** respectively.

The pressing function of the cam pin **11c** or **12c** is derived from a tensile force of a coil spring **18** which is fastened to tighten between a lens frame **11a** and **12a**. That is, the coil spring **18** is a spring for tensile force, one end of which is fixed to the lens frame **11a**, another end of which to the lens frame **12a** and gives a spring force in a direction for approaching these lens frames **11a** and **12a** each other whereby the cam pin **11c** and the cam pin **12c** press the first cam plane and the second cam plane respectively.

The cam for zooming **17** is rotated through a rate reducing device by a motor **19** and the cam pin **11c**, **12c** are driven along the first and second cam plane **17a**, **17b** whereby the first lens group and the second lens group move along a direction of the optical axis for zooming.

A camera which zooms a viewfinder optical system using the above mentioned cam for zooming 17 is already publicly known (see Japanese laid open patent publication JP1998-161194).

Fig. 46 shows a driving mechanism for zooming **110** provided with a cam for zooming **111** having a first cam groove **111a** and a second cam groove **111b**. In the driving mechanism for zooming, the cam pin **11c** of the first lens group **11** and the cam pin **12c** of the second lens group **12** are plunged in to the first cam groove **111a** and the second cam groove **111b** respectively.

Thus, as the cam pins **11c**, **12c** are driven in concordance with rotation of the cam for zooming **111**, zooming is performed by moving the first lens group **11** and the second lens group **12** along a direction of the optical axis. Other structure of the driving mechanism for zooming **110** is the same as that of a driving mechanism for zooming **10** shown in Fig. 45.

A camera having zooming function is provided with a lens barrel which is advanced and retreated corresponding to zooming, whereby a focus of photographic lens varies, as is widely known (see Japanese laid-open patent publication JP2002-72043).

More particularly, a lens barrel comprises a moving frame which holds a zoom lens, a cam frame and a fixed frame combined altogether, wherein the moving frame is advanced and retreated along the optical axis by driving a cam pin provided on the moving frame with a cam groove of the cam frame. The cam frame, which is rotated, has an interlocking gear mechanism and a motor in a portion of the lens barrel as a driving unit.

A so called electronic camera in which an image capturing element is disposed at an image focus position of a photographic lens and photographic data generated by the image capturing element are stored in a memory is widely known. The electronic camera of this type has an image capturing element attached to the fixed frame of the lens barrel (see Japanese laid open patent publication JP1990-71678).

More particularly, a standard plane is formed on a fixed frame portion which is around the image focus portion of the photographic lens. And the image capturing element is fixed to a metallic plate with adhesive.

The metallic plate has a flange portion projecting from both sides of the image capturing element. The flange portion is superposed on the standard plane and fixed with screws on the fixed frame. In many electronic cameras, an image capturing element is fixed with the above mentioned configuration to a lens barrel.

SUMMARY OF THE INVENTION

One of the objects of the present invention is to make an image capturing apparatus such as electronic camera thinner.

In order to attain the above object, according to the present invention, in an electronic camera comprising an operation unit having a display unit and an image capturing unit provided with a flash unit and a photographic zoom lens, the image capturing unit connected rotatably by a hinge mechanism and transmitting an image signal to the display unit, an image capturing apparatus is characterized in that an outer diameter of the lens is defined to a thickness of the display unit disposed on the operation unit, a memory, a battery and a control circuit board, a casing is supported on a lens frame through which a guide shaft is pierced so as to move the lens back and forth as well as a cam for moving the zoom lens is disposed at the side of a lens system so that camera is made thinner.

According to the present invention, An optical zoom mechanism comprises a zoom lens, a holding frame which holds the zoom lens, a rotational axis rod having gears at the both end thereof, a first group of rate reducing gears which engage the gear at one end of the rotational axis rod, a second group of rate reducing gears which engage the gear at another end of the rotational axis rod, a motor which drives the second group of rate reducing gear and a cam body driven by the first rate reducing gears whereby zooming is performed by moving the holding

frame with the cam body.

Further according to the present invention, in a cam apparatus having a spiral cam grooves for moving an object with a cam driving force which is generated by cam driving a cam groove inserting member inserted in the cam groove, a cam apparatus comprises one cam body having one cam plane of a cam groove, another cam body having another cam plane confronting said one cam plane, which is provided non-rotatably to the cam body so as to be able to slide, and a forcing device contacting a cam groove inserting member by pressing one cam body and /or another cam body.

Yet further according to the present invention, in a cam apparatus having first and second spiral cam grooves for moving an object with a cam driving force which is generated by cam driving a cam groove inserting member inserted in each cam groove, a cam apparatus comprises a cam base body in which sliding portions having a smaller diameter than that of a middle portion of a cylinder are formed at both ends of the cylinder, an approximately vertical plane of a stepped portion between one sliding portion and the middle portion of the cylinder is defined as one cam plane of the first cam groove and an approximately vertical plane of a stepped portion between the other sliding portion and the middle portion of the cylinder is defined as one cam plane of the second cam groove; a first cam frame having another cam plane confronting the one cam plane of the first cam groove and provided non-rotatably so as to be able to slide on one sliding portion; a second cam frame having another cam plane confronting the one cam plane of the second cam groove and provided on the other sliding portion non-rotatably so as to be able to slide; and a forcing device which contacts a cam groove inserting member which is inserted to the cam groove formed by the first and the second cam frames and the cam base body on to the cam plane by pressing the first and the second cam frames.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an over all view of an electronic camera in one embodiment of the present invention.

Fig. 2 is a perspective illustration of an electronic camera in one embodiment of the present invention, which shows a photographing state in case a lens is targeted to an object.

Fig. 3 is a perspective illustration of an electronic camera in one embodiment of the present invention, which shows a photographing state in case a lens is targeted to a photographer, him or herself.

Fig. 4 is an illustration of an electronic camera in one embodiment of the present invention, which shows a held state in case a lens is targeted to an object.

Fig. 5 is a perspective illustration in one embodiment of the present invention, which shows a mounted state of inner devices in an operation unit **102**, whose cover is opened, of an electronic camera **100** and image capturing devices such as a flash unit, condenser and CCD in an image capturing unit **101**.

Fig. 6 is perspective illustrations in one embodiment of the present invention of an electronic camera **100**, which shows a view of the uncovered state without a display unit 105 (A) of an operation unit **102** and a backside view (B) of an operation unit **102**.

Fig. 7 is drawings in one embodiment of the present invention, which shows an elevational view of the uncovered state from front side in Fig. 5 without a display unit **105** (A), an elevational view from left side in Fig. 5 (B) and a sectional view from left side in Fig. 5 of an operation unit **102** of an electronic camera **100**.

Fig. 8 is a perspective illustration in one embodiment of the present invention of an electronic camera, which shows an image capturing unit without an upper cover.

Fig. 9 is an exploded view of an image capturing unit in one embodiment of the present invention of an electronic camera.

Fig. 10 is an exploded view of a lens system of an image capturing unit in one embodiment of the present invention of an electronic camera.

Fig. 11 is a schematic drawing in one embodiment of the present invention of an electronic camera, which illustrates a configuration of an image capturing element of an image capturing unit.

Fig. 12 is a schematic drawing in one embodiment of the present invention of an electronic camera, which illustrates a configuration of a rear fixing frame to which an image capturing element of an image capturing unit is attached.

Fig. 13 is a perspective illustration of a cam for zooming in a zooming mechanism.

Fig. 14 is an explanatory drawing in one embodiment of the present invention of an electronic camera, which illustrates a cam driving mechanism for zooming of an image capturing unit

Fig. 15 is a cross sectional drawing in one embodiment of the present invention of an electronic camera, which shows a cam driving mechanism for zooming.

Fig. 16 is an explanatory drawing of a focus mechanism.

Fig. 17 is a drawing in one embodiment of the present invention of an electronic camera, which shows a second embodiment of a cam for zooming.

Fig. 18 is a cross sectional drawing in one embodiment of the present invention of an electronic camera, which shows a second embodiment of a cam driving mechanism for zooming of a zoom cam in an image capturing unit.

Fig. 19 is a cross sectional drawing in one embodiment of the present invention of an electronic camera, which shows an driving mechanism using a cam for zooming **25** of an image capturing

unit in a third embodiment.

Fig. 20 is a partially enlarged cross sectional drawing in one embodiment of the present invention of an electronic camera, which shows an driving mechanism using a cam for zooming **25** of an image capturing unit in a third embodiment.

Fig. 21 is cross sectional drawings in one embodiment of the present invention of an electronic camera, which show other embodiments in case a cam plane slanting position of a first or a second cam groove **40, 41** is varied in a cam for zooming of an image capturing unit of a third embodiment.

Fig. 22 is a schematic drawing in one embodiment of the present invention of an electronic camera, which shows another example of a driving mechanism using a cam for zooming 25 of an image capturing unit of a third embodiment.

Fig. 23 is a schematic drawing in one embodiment of the present invention of an electronic camera, which shows another example of a driving mechanism using a cam for zooming 25 of an image capturing unit of a third embodiment.

Fig. 24 is a perspective illustration in one embodiment of the present invention of an electronic camera **100**, which shows a hinge mechanism connecting an image capturing unit **101** to an operation unit **102**.

Fig. 25 is a perspective illustration showing a connecting portion in which a hinge mechanism is mounted to an image capturing unit **101** and an upper cover **307** and inner component members of an operation unit **102** are removed.

Fig. 26 is a perspective illustration of a decomposed hinge mechanism shown in Fig. 24.

Fig. 27 is a perspective illustration showing one embodiment of a driving mechanism for

zooming in an electronic camera having a zoom apparatus as a cam for zooming.

Fig. 28 is a front elevational view of the above driving mechanism for zooming.

Fig. 29 is a perspective illustration of a driving mechanism for zooming, which shows a constitutive part of a cam for zooming.

Fig. 30 is a perspective illustration of a cam for zooming.

Fig. 31 is an exploded perspective illustration of a cam for zooming.

Fig. 32 is a camera plan view of showing as an example of an electronic camera having a driving mechanism for zooming.

Fig. 33 is a camera front elevational view of an electronic camera shown in Fig. 32.

Fig. 34 is a camera rear elevation view of an electronic camera shown in Fig. 32.

Fig. 35 is a camera front elevational view showing an example of a photographing state of the electronic camera shown in Fig. 32.

Fig. 36 is a perspective illustration of an optical system absorption part of the electronic camera shown in Fig. 32 when a rear case is removed.

Fig. 37 is a transverse sectional view of the above optical system absorption part.

Fig. 38 is an exploded perspective illustration of the above optical system absorption part.

Fig. 39 is a perspective illustration of a driving mechanism for zooming provided to the above optical system absorption part.

Fig. 40 is an exploded perspective illustration of a cam for zooming provided to the driving mechanism for zooming shown in Fig. 39.

Fig. 41 is a perspective illustration of a rate reducing device having the driving mechanism for zooming shown in Fig. 39.

Fig. 42 is a perspective illustration of an optical system installed part showing an image capturing unit and a mounting structure of the image capturing unit.

Fig. 43 is a perspective illustration of an optical system installed part showing a mounted state of an image capturing unit.

Fig. 44 is a perspective illustration of an optical system installed part showing a state that an image capturing unit together with a circuit board is actually mounted.

Fig. 45 is a perspective illustration of a driving mechanism for zooming as a prior art.

Fig. 46 is a perspective illustration of a driving mechanism for zooming similar to Fig. 45 as another prior art.

Fig. 47 is an enlarged partial sectional view of a configured portion of a cam groove with a cam pin of a conventional cam for zooming.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will now be described in detail by way of example with reference to the accompanying drawings. It should be understood, however, that the description herein of specific embodiments such as to the dimensions, the kinds of material, the configurations and the relative disposals of the elemental parts and the like is not intended to limit the invention to the particular

forms disclosed but the intention is to disclose for the sake of example unless otherwise specifically described.

First Embodiment

In order to comply with recent needs for a thin and high magnification of a camera, further improvement is necessary. Accordingly, in a following embodiment it is an object to describe a camera having such a strength and a thickness as capable of shoving in a breast pocket of a dress shirt or in a hip pocket of jeans and such a lightness as make one no sense of discomfort when it is put in these places or a handbag, and yet having a zoom mechanism of high and precise magnification.

Fig. 1 is an over all view of an electronic camera in this embodiment. Fig. 2 is an illustration of an electronic camera in this embodiment, which shows a photographing state in case a lens is targeted to an object. Fig. 3 is an illustration of an electronic camera in this embodiment, which shows a photographing state in case a lens is targeted to a photographer, him or herself. Fig. 4 is an illustration of an electronic camera in this embodiment, which shows a held state in case a lens is targeted to an object.

In the drawings, **100** is an electronic camera in this embodiment. **101** is an image capturing unit, 102 is an operation unit, 103 is a photographic lens window, 104 is a flash unit window such as a strobe, 105 is a display uni using such as LCD, 106 is a shutter button, 107 is a power button, 108 is a selection and decision key for selecting a function or an item which is displayed on the display unit **105** comprising a cross key and a decision key, 109 is a zoom key which bids optical system zooming and a menu button which changes on and off of a camera mode menu respectively. **111** is a display button, which changes on and off of display contents and light, and 112 is a scene button, which changes a display content of the display unit **105** to a scene selecting screen page respectively. **113** is a mode selecting button which select modes such as an aperture priority mode, a shutter priority mode, sports mode for photographing rapidly moving objects, a macro mode for photographing near objects, strobe control of enforced flashing of strobe or

flashing halt, movie shooting and movie play back. **114** is a speaker.

In an electronic camera **100** in this embodiment, as shown in Fig. 1-3, display unit **105**, general operational buttons for photographing **106-113** are disposed on the operation unit **102** side to which the image capturing unit **101** is connected rotatably by a hinge mechanism. The photographic lens window **103** is disposed on one side of the image capturing unit **101** and the flash unit window **104** is disposed on side of the operation unit **102**. The operational buttons for photographing **106-113** are provided on the operation unit 102 so as not to project from the surface of the outer cover of the operation unit 102 whereby making one no sense of discomfort or getting stucked when shoving in a breast pocket of a dress shirt or in a hip pocket of jeans. Further, the shutter button **106** is positioned so as to be operable with a pointing finger when the camera 100 is held with a right hand. Further, the shutter button **106** is positioned so as to be operable with a pointing finger when the camera **100** is held with a right hand. The zoom key **109**, the selection and decision key **108**, the menu button **110**, and the mode selecting button **113** are likewise disposed within the reaching distance for a thumb finger when the camera **100** is held with a right hand whereby operationality is upgraded. The buttons **106**, **109** which are used mainly for photographing are disposed apart from the display unit **105** so that fingers don't touch the display unit **105**.

In the camera **100** of this embodiment, while the display unit **105** is pointed at a photographer so as to be always visible, the image capturing unit **101** is pointed at an object as shown in Fig. 2 or the photographing lens window **103** is pointed at a camera operator him or herself by reversely rotating the image capturing unit as shown in Fig. 3, whereby self photographing is possible. Further, in the electronic camera **100** of this embodiment, when a length L1 between the end of the photographic window **103** side and the end of the flash unit window 104 side of the image capturing unit **101** be, for example, a length between a tip of a forefinger of a left hand and near a second arthrosis of the finger, and a length of a reverse side of the photographic lens window be L2, a thickness L3 along a direction of an optical axis of a portion of the flash unit window **104** corresponding to the portion L1-L2 is a thickness of a forefinger and the portion is roundly flared to the operation unit **102** side (see Fig. 3). Thus, a space for disposing operational

buttons at the right side of the display unit **105** of the operation unit **102** is secured, whereby the electronic camera can be made small and of a good operationality. A distance between the photographic window **103** and a rotational center of the hinge mechanism is greater than a distance between an end of a reverse side to the photographic window **103** and the rotational center of the hinge mechanism.

Thus, when a photographer photographs by pointing the photographic lens window **103** at him or herself a length between a display screen of the display unit and the photographic lens window **103** becomes great. Therefore, when a photographer recognizes a display screen from a gap between photographic lens window **103** and the display screen by slanting the display unit **105** with respect to a visible direction of the photographer, the photographer obtains a good visibility of the whole screen as the gap is long owing to the long distance between the display screen and the photographic lens window **103**.

When the electronic camera **100** is used, a power button **107** is pushed to activate the power and each button is operated. Any mode is selected by the menu button **110** with the mode selecting button **113** such as a photographing condition of an aperture priority mode or of a shutter priority mode, a sports mode photographing a body moving rapidly, a macro mode which photographs near objects, a strobe control of enforced flashing or flashing halt, and a movie shooting or movie play back. An item is selected by the selection and decision key **108** comprising a cross key and decision key and decided by pushing a center decision button as needed after displaying a variety of menus such as a size of an image, a photographic sensitivity, and a photometry method on the display unit **105** by pushing the menu button **110**.

When the photographic window is pointed at a object as shown in Fig. 2, the operation unit **102** is held with a right hand as shown in Fig. 4 and a portion of L3 (see Fig. 3) of the image capturing unit **101** having a length of L1 (see Fig. 3) is held with a fore finger and a middle finger and the photographic window **103** is pointed at the object. After a predetermined magnification is determined by operating the zoom key **109** of the image capturing unit **101** with a thumb of the right hand while seeing a object displayed on the display unit **105**, the shutter

button **106** is pushed with a forefinger of the right hand to automatically determine exposure and focus so that a captured image signal by a built-in image capturing element such as CCD is stored in a built-in memory. By photographing in this way, since a distance between the photographic lens window **103** of the image capturing unit **101** and the rotational center of the hinge mechanism is greater than a distance between the rotational center of the hinge mechanism and an end of a reverse side to the photographic window **103**, a lens unit is largely rotated so that the image capturing unit can be rapidly pointed at an object and the camera **100** can be held tightly.

After thus photographing, when a mode is turned to a playback mode with a mode selecting button **113**, an image signal stored in the memory is displayed on the display unit **105** and captured images can be sequentially displayed on the display unit by operating the cross key of the selection and decision key **108**. In case of a movie shooting mode, a movie signal is stored in a memory and is played back together with sound at the same time from the speaker **114** by selecting a necessary scene with the scene button **112**.

A configuration of the operation unit **102** is explained as follows.

Fig. 5 is a perspective illustration in one embodiment of the present invention, which shows a mounted state of inner devices in an operation unit **102**, whose cover is opened, of an electronic camera 100 and image capturing devices such as a flash unit, condenser and CCD in an image capturing unit **101**. Fig. 6 is perspective illustrations in one embodiment of the present invention of an electronic camera **100**, which shows a view of the uncovered state without a display unit **105** (A) of an operation unit 102 and a backside view (B) of an operation unit 102. Fig. 7 is drawings in one embodiment of the present invention, which shows an elevational view of the uncovered state from front side in Fig. 5 without a display unit **105** (A), an elevational view from left side in Fig. 5 (B) and a sectional view from left side in Fig. 5 of an operation unit **102** of an electronic camera **100**.

In this drawing, **300** is a main circuit board; **301** is a memory slot in which a memory card storing an image signal is received; **302** is a battery; **303** is a sub circuit board controlling the image capturing unit **101**; **304** is a flexible board for mode control; **306** is a microphone, **307** is

an upper cover; **308** is a under cover; **309** and **310** are pole braces for supporting approximately center part of the main circuit board **300** provided between the upper cover **307** and the under cover **308**; **320** is an image capturing element of the image capturing unit **101** side such as a CCD; **321** is a flash unit of the image capturing unit **101** side such as a strobe; **322** is a condenser for the flash unit of the image capturing unit **101** side such as a strobe; and **323** is a print circuit board for the flash unit.

In an electronic camera **100** of this embodiment, the speaker **114** and the buttons such as the shatter button **106**, the power button **107**, the section and decision key **108**, the zoom key **109**, the menu button **110**, the display button **111**, scene button **112**, and the mode select button **113** shown in Fig. 1 are attached on the upper cover **307** of the operation unit **102** shown in a sectional view of Fig. 7 (C). A window for the display unit **105** shown in Fig. 5 is also provided and the flexible circuit board for mode control **304** is disposed around the display unit **105**. The memory slot **301**, which receives a memory card for storing an image signal is provided in the upper side under the flexible circuit board **304** for mode control and the display unit **105** and a main circuit board **300** having a thin battery **302** is provided in the lower side as shown in Fig. 6(B). These are stacked together as shown in Fig. 7(B). Further, the sub circuit board **303** is disposed at the lateral side of the battery **302** under the main circuit board **300** for controlling the image capturing unit as shown in Fig. 6 and Fig. 7 (A).

The main circuit board **300** is positioned with positioning portions provided to corners of the under cover **308** and held between the upper and under covers while the pole brace **310** of the upper and under cover **307**, **309** is let through the hole **311** provided at the center of the main circuit board **300** as shown in Fig. 7 (C) so as to be supported flexibly with respect to a deflection of the case. That is, in case the whole electronic camera **100** is made thin and it is shoved into a breast pocket of a dress shirt or a hip pocket of jeans notwithstanding that a CPU and others which control the whole electronic camera are mounted on the main circuit board **300**, a big deflection force is exerted to the case consisting of the upper cover **307** and the under cover **308**. Accordingly, if a main circuit board **300** having a CPU and others is fixed with a screw or the like to a case, the main circuit board is deflected by a deflection force, leading to a trouble that

the solder mounted CPU is peeled off in a worst case. Therefore, in the present embodiment, the deflection force is released by holding the approximately center portion of the board with the poles **309, 310** as the corners of the main circuit board **300** are only positioned.

Next, a configuration of the operation unit **102** is explained as follows. Fig. 8 is a perspective illustration in one embodiment of the present invention of an electronic camera, which shows an image capturing unit without an upper cover. Fig. 9 is an exploded view of an image capturing unit in one embodiment of the present invention of an electronic camera. In the drawings, **400** is a lens unit containing a driving mechanism for zooming; **401** is a under cover of the image capturing unit; **402** is a upper cover of the same; **403** is a cover plate for covering so as not to enter dirt in the optical system when mounting lens unit **400**; **404** is a lens window in which the photographic lens window is installed; **405** is a hinge mechanism so as to be capable of rotating the image capturing unit **101** with respect to the operation unit **102**; 406 is a push pin to press a cam for zoom mentioned later with a pressing force of a coil spring **407**; and **408** is an image capturing element unit.

In the image capturing unit **101** of the electronic camera **100** of this embodiment, as explained in Fig. 3 above, when a length L1 between the end of the photographic window **103** side and the end of the flash unit window 104 side of the image capturing unit **101** be, for example, a length between a tip of a forefinger of a left hand and near a second arthrosis of the finger, and a length of a reverse side of the photographic lens window be L2, a thickness L3 along a direction of an optical axis of a portion of the flash unit window **104** corresponding to the portion L1-L2 is a thickness of a forefinger and the portion is roundly flared to the operation unit **102** side.

In the image capturing unit **101** of the electronic camera **100** of this embodiment, a height of a lens frame of a lens group comprising a zoom lens of the lens unit **400** is restricted to an approximate value of the sum of the display unit **105** disposed in the operation unit **102**, the memory slot **301** which receives a memory card storing an image, the main circuit board **300** and the battery **302**; a generally disc shaped shutter is configured to as a quadrangular shape having the same height as the lens frame letting the outer circumference of these lens frame and shutter be a supporting plane of the case comprising the upper and under covers. Further, a total

length of the zoom lens along the optical axis is restricted to a height of battery **302** as shown in Fig. 6(B); a driving mechanism for zoom lens and a control circuit board **323** of a flash unit **321** in the image capturing unit **101** and others are disposed in a lateral space of the optical system; and electrical components such as a condenser for the flash unit **322** are disposed in a back space opposite to the photographic lens window **103** of the optical system.

Thus, a total length of the optical system does not vary even when the power of the electronic camera **100** is on and off by restricting a total length of the zoom lens along the optical axis to a height **h** of the battery **302** in Fig. 6(B) and disposing the driving mechanism for the zoom lens to a side of the optical system. As a lens is unnecessary to be drawn and stored every time when the power is on and off like a conventional camera, photographing is possible as soon as the control system is operated so that a photographing opportunity is never missed. In case lens groups increase owing to high magnification, it is possible to add up lens groups utilizing the space opposite to the photographic lens window **103** where electric components such as the condenser for the flash unit **322** are disposed.

Next, referring to Fig. 10 -16, a lens unit 400 of a image capturing unit 101 having a driving mechanism for zoom is explained in this embodiment of a electronic camera 100. Fig. 10 is an exploded view of a lens system of an image capturing unit in one embodiment of the present invention of an electronic camera. Fig. 11 is a schematic drawing in one embodiment of the present invention of an electronic camera, which illustrates a configuration of an image capturing element of an image capturing unit; Fig. 12 is a schematic drawing in one embodiment of the present invention of an electronic camera, which illustrates a configuration of a rear fixing frame to which an image capturing element of an image capturing unit is attached; Fig. 13 is a perspective illustration of a cam for zooming in a zooming mechanism; Fig. 14 is an explanatory drawing in one embodiment of the present invention of an electronic camera, which illustrates a cam driving mechanism for zooming of an image capturing unit; Fig. 15 is a cross sectional drawing in one embodiment of the present invention of an electronic camera, which shows a cam driving mechanism for zooming; and Fig. 16 is an explanatory drawing of a focus mechanism.

21 is a first lens group; **21a** is a lens frame of a first lens group **21**; **21b** is a boss (bearing portion)provided on the lens frame **21a**; **21c** is a cam pin provided on the boss **21b**; **22** is a second lens group; **22a** is a lens frame of the second lens group; **22b** is a boss (bearing portion)provided on the lens frame **22a**; **22c** is a cam pin provided on the boss **22b**; **23, 24** is a guide shaft, one end of which is fixed to a front fixing frame **27** and another end of which is fixed to a rear fixing frame **28**; **25** is a cam for zooming; **26** is a motor for zooming; **27** is a front fixing frame; **27a** is a bearing portion; **27b** is a window hole through which an object image light is passed; **28** is a rear fixing frame; **28a** is a window hole through which an object image light is passed and right behind the window hole of a rear fixing frame 28, an image capturing element unit **408** comprising such as CCD shown in Fig. 9 is mounted; **29** is a supporting fixing frame (Fig. 14); **29a** is a bearing portion provided on the supporting fixing frame **29**(Fig. 15); **31** is a third lens group which is moved by a lead screw **34** rotated with a motor for focusing **33**(Fig, 10) provided on the rear fixing frame (Fig. 16); **31a** is a lens frame of the third lens group **31**; **31b** is a boss provided on the lens frame **31a** having a hole through which the guide shaft **23** is pierced; **32** is a nut screw which advances and retreats the third lens group **31** by moving with the lead screw 34 rotated by the motor for focusing **33**(Fig. 10); **35** is a shutter unit; and **39** is a spring for preventing from a play of the third lens group. If the motor for zooming **26** and a motor for focusing **33** are disposed at the same place piling on top of another, two magnetic fields generated by two magnetic coils of the motors affect each other so that erroneous activation occurs. To avoid the occurrence, two motors are disposed at the both ends along the optical axis in the optical system as shown in Fig. 10.

In Fig. 13 and 14, **40** is a first cam groove of the cam for zooming **25**; **40a** is one cam plane of the first cam groove; **40b** is another cam plane; **41** is a second cam groove of the cam for zooming **25**; **41a** is one cam plane; **50a** is another cam plane; **52** is a zoom shaft for communicate a driving force to a gear **55** of the cam for zooming **25** by engaging a gear provided on the shaft of the motor for zooming **26**; **56** is a cam for zooming (1); 57 is a cam for zooming (2); 58 is a cam for zooming (3); **59** is a cam for zooming (4).

In the electronic camera **100** of this embodiment, a zoom lens of the image capturing unit **101** comprises, as shown in an exploded view of Fig. 10, a first lens group **21**, a second lens group **22**, and a third lens group **31** for focusing shown in Fig. 16 provided on the portion of the rear fixing frame **28** in Fig. 10 as photographic lenses wherein zooming and focusing is performed with these first to third lens groups. A guide shaft **23** is pierced through a boss (a bearing portion) **21b** provided on the lens frame **21a** of a first lens group **21**, a boss (a bearing portion) 22b provided on the lens frame **22a** of a second lens group **22**, and a boss (a bearing portion) **31b** provided on the lens frame **31a** of a third lens group **31** for focusing shown in Fig. 16. A guide shaft **24** is further pierced through a hole **21d**, **22d** or **31d** provided at the positions each opposite to the boss **21b**, **22b** or **31b** so that the first to the third lens groups can advance and retreat along the optical axis as being held by the guide shafts **23**, **24**. A cam for zooming **25** shown in Fig. 13 and 14 is disposed on the lateral side of the first and the second lens groups to advance and retreat the first and the second lens groups, preventing to reduce the thinness of the electronic camera **100** itself by the driving system of the zoom lens.

Thus, since the camera is tried to be made thin by restricting an outer diameter of the lens to a thickness of the sum of each thickness of LCD, a memory, a battery or a control circuit board indispensable to recognition and record of images for a electronic camera, by deposing the cam for moving the zoom lens at the lateral side of the lens system, letting the lens move back and forth by defining the lens frame as a supporting plane of the case and by piercing the guide shaft through the lens frame, these components do not become thicker than the sum of the thickness of LCD, a memory, a battery and a control circuit board, whereby the electronic camera can be configured very thin.

In an electronic camera **100** of this embodiment, an image capturing element unit **408** comprising a CCD is, as shown in Fig. 11, has a CCD rubber **351** for protecting the CCD, low pass filter **352**, a CCD mask **353**, a low pass filter holder **351** at the object side of an image capturing element **320** such as CCD, which are fixed with a screw **356** to a CCD plate **355** made from rigid material, and leads of the image capturing element **320** soldered with a print circuit board **358** is fixed with a spring to a rear fixing frame **28** as shown in Fig. 12. That is, in Fig. 12,

360 is a leaf spring which restricts a direction of up and down for the image capturing element unit **408** configured as shown in Fig. 11, and **361** is also a leaf spring which restricts a direction of left and right. These leaf springs fixes the image capturing element unit **408** configured as shown in Fig. 11 on a standard plane **362, 363, 364** of the rear fixing frame **28.**

Though it is a general practice that a image capturing element 320 is fixed with a screw to a case side in this type of electronic camera, in case a camera is made thin like this embodiment of the electronic camera **100,** each member is thin and deflection of the case arises, an image may be affected due to propagation of the deflection. Accordingly, the low pass filter and others are integrated to be fixed with leaf springs **361, 362** so that mounting becomes simplified and an image is not affected eve if a deflection force is applied to the case.

In the driving mechanism for zooming configured as above, the first and second lens group **21, 22** moves for zooming along the guide shaft **23, 24** by driving rotatably the cam for zooming **25** with the motor for zooming **26**; and the third lens group **31** moves for focusing by moving the nut screw with the lead screw **34** (Fig. 16) driven rotatably with the motor for focusing **33.** The third lens group moves even when zooming.

A cam pin **21c** as a member for inserting into the cam groove **40** and a cam pin **22c** as a member for inserting into the cam groove **41** is projectingly formed on the boss **21b** and the boss **22b** of the first lens group **21** and the second lens group **22** respectively. Meanwhile, the cam for zooming **25** is a cylindrical cam having a first cam groove **40** and a second cam groove **41** as shown in Fig. 14. As shown in Fig. **13,** the cam for zooming comprises a cylindrical cam for zooming (1) **56,** a cam for zooming (2) **57,** a cylindrical cam for zooming (3) **58,** (4) **59** fitting to both ends of the cam for zooming (1) **56** and the cam for zooming (2) **57** so as to be capable of sliding, a push pin **406** and a coil spring **407** shown in Fig. 15 pressing the cam for zooming (3) **58** and the cam for zooming (4) **59** in a direction of approaching each other.

The cam for zooming (2) **57** has a shaft portion **57d** having a smaller diameter made by D-cutting, the shaft portion being able to insert into a hole **56d** which receives the D-cut portion.

Further, the cam for zooming (1) **56** and the cam for zooming (2) **57** have a sliding portion **56b** and **57b** respectively having a smaller diameter at the opposite side of middle portion **56a, 57a**. Stepped portions between the middle portions **56a**, **57a** and the sliding portions **56b**, **57b** are formed as one cam plane **40a** and one cam plane **41a** for forming the first cam groove **40** and the second cam groove **41**. The cam for zooming (1) **56** and the cam for zooming (2) **57** have long holes **56c**, **57c** into which unshown protruded portions provided on the cam for zooming (3) **58** and the cam for zooming (4) **59** are inserted so as to be able to slide, whereby the cam for zooming (3) **58** and cam for zooming (4) **59** are rotated together with the cam for zooming (1) **56** and the cam for zooming (2) **57**. A stepped portion **56e** formed on the end portion of the cam for zooming (1) **56** is for restricting moving the cam for zooming (3) **58**. Each end circumferential portion of the cam for zooming (3) **58** and the cam for zooming (4) **59** has another cam plane **40b** for forming the first cam groove **40** and another cam plane **41b** for forming the second cam groove **41**.

The D-cut shaft portion **57d** of the cam for zooming (2) **57** formed in a manner mentioned above is fit into the hole **56d** which receives a D-cut portion provided to the cam for zooming (1) **56**.The cam for zooming (3) **58** is fitted to the sliding portion **56b** of the cam for zooming (1) **56** and the cam for zooming (2) **57** to the sliding portion **57b** of the cam for zooming (4) **59** and fixed with the bearing portion **27a** of the front fixing frame **27** and the bearing portion **29a** of the supporting fixing frame **29** provided to the rear fixing frame **28** as shown in Fig. 14, Fig. 15. The cam for zooming (3) **58** and the cam for zooming (4) **59** are pressed in a direction of approaching each other with the push pin **406** pressed by the coil spring **407** inserted into the bearing portion **27a** of the front fixing frame **27**. The cam for zooming (3) **58** slides on the sliding portion **56b** and the cam for zooming (4) **59** slides on the sliding portion **57b**. The first cam groove **40** is formed by one cam plane **40a** and another cam plane **40b** and the second cam groove **41** is formed by one cam plane **41a** and another cam plane **41b**. Accordingly, the formed cam grooves **40** and **41** become spiral cam grooves fit to moving of the first and second lens groups necessary for zooming.

The cam pin **21c** which is projectingly formed on the boss 21b of the first lens group **21** as

explained in Fig. 10 is inserted into the cam groove **40** and the cam pin 22c which is projectingly formed on the boss **22b** of the second lens group **22** is inserted into the cam groove **41** as shown in Fig. 15. Since the cam for zooming (3) **58** and the cam for zooming (4) **59** are slid in a direction of departing from the cam for zooming (1) **56** and the cam for zooming (2) **57** by the insertion, the cam pin **21c** is pressed to the cam plane **40b** of the cam for zooming (4) **59** and the cam pin **22c** is pressed to the cam plane **41b** of the cam for zooming (3) **58**. Therefore, these cam pin **21c** and **22c** contact the cam plane with a definite contact pressure over the whole region of the cam grooves **40** and **41**. As a pressing force of the cam pin **21c**, **22c** to the cam planes can be determined by a pressing force of the coil spring **407**, a pressing force of the cam pins **21c** and **22c** can be made most appropriate, if a coil spring having appropriate pressing force is chosen.

Thus, the cam for zooming (1) **56** can be rotated with a definite driving force for rotation and the driving for moving the first lens group and the second lens group **21**, **22** can be performed smoothly. As a result, a small motor consuming a little electricity can be used as a motor for zooming for the cam for zooming **25** becomes a cam apparatus having a light load and a little fluctuation.

Since, in addition that the cam pins **21c**, **22c** become a cam for zooming **25** having a definite pressure over the whole region the cam grooves **40** and **41**, the motor for zooming **26** is disposed coaxially to the cam for zooming **25**, a width in a lateral direction of the image capturing unit **101**(L2 in Fig. 3) can be reduced. Further, since the first and the second lens groups **21**, **22** for zooming and the third lens group **31** are supported and moved by the same guide shafts **23**, **24**, the lenses are difficult to fall or become eccentric.

The above is a zoom mechanism of the lens unit **400** in the electronic camera **100** of this embodiment. A lot of methods are thought of as mechanisms for rotating the cam for zooming **25** by a definite driving force of a motor. First, Fig. **17** shows a second embodiment and Fig. **18** shows a sectional view of a driving mechanism using the cam for zooming **25**. In the following explanation, a same number is attached to a same constituent element mentioned above.

A cam for zooming **25** of the second embodiment, shown in Fig. 17, comprises a cylindrical cam base body **251** having a first cam groove **40** and a second cam groove **41**, a cylindrical cam frames **252**, **253**, fit to the both sides of the cam base body **251** so as to be able to slide and a coil spring **254** of tensile force for pressing these cam frame **252**, **253** in a direction of approaching each other.

A cam base body **251** has a sliding portions **251b**, **251c** having a smaller portion at the both sides of the middle portion **251a**. One cam plane **40a** is formed for forming a first cam groove **40** at a stepped portion between the middle portion **251a** and the sliding portion **251b**. One cam plane **41a** is formed for forming a first cam groove **41** at a stepped portion between the middle portion **251a** and the sliding portion **251c**. The cam base body **251** has long holes **251d**, **251e** along an axial direction from the both ends, into which protruded portions **252a**, **253a** are fit so as to be able to slide, whereby the cam frames **252**, **253** are rotated together with the cam base body **251**. A hole portion **251f** formed at the ends of sliding portion **251b**, **251c** is to attach a coil spring **254**. Stepped portions **251g**, **251h** are to restrict the movement of said cam frame **252**, **253**.

Meanwhile, a cam frame **252** has another cam plane **40b** for forming a first cam groove **40** at one end circumference portion and further has a pointing inner flange **252b**. The cam frame **252** has a spring hooking portion **252c** projected from the protruded portion **252a** in the cylinder.

A cam frame **253** has another cam plane **41b** for forming a first cam groove **41** at one end circumference portion and further has a pointing inner flange **253b**. The cam frame **253** has a spring hooking portion **253c** projected from the protruded portion **253a** in the cylinder.

With regard to the cam base body **251**, the cam frames **252**, and **253**, after the cam frame **252** is fit to the sliding portion **251b** of the cam base body **251** and the cam frame **253** is fit to the sliding portion **251c**, one end of coil spring **254** is hooked to the spring hooking portion **252c** of the cam frame **252** and another end is hooked to the spring hooking portion **253c** of the cam frame **253**. Then the coil spring **254** presses the cam frame **252** and **253** in a direction of approaching each other so that the flange portion **252b** advances until it strikes the stepped

portion **251g** as the cam frame **252** slides the sliding portion **251b**. With this state, the first cam groove is formed by the one cam plane **40a** and the other cam plane **40b**. Likewise, the cam frame **253** slides the sliding portion **251c** and the flange portion **253b** advances until it strikes the stepped portion **251h** so that the second cam groove is formed by the one cam plane **41a** and the other cam plane **41b** with this state. Thus formed cam grooves **40, 41** become spring shaped cam grooves matched with movement of the first and second lens groups **21, 22** necessary to zooming.

As explained in Fig. 15, as for the cam grooves **40, 41** of the cam for zooming **25**, the cam pin **21c** formed projectingly on the boss **21b** of the first lens group **21** is inserted into the cam groove **40** and the cam pin **22c** formed projectingly on the boss **22b** of the second lens group **22** is inserted into the cam groove **41**. By the insertion, the flange portion **252b** of the cam frame **252** retreats a little from the stepped portion **251g** and likewise, the flange portion **253b** of the cam frame **253** retreats a little from the stepped portion **251h**. Therefore, since the cam pin **21c** is pressed to the cam plane **40b** of the cam frame **252** and the cam pin **22c** is pressed to the cam plane **41b** of the cam frame **253**, the cam pins **21c, 22c** contact to the cam plane with a definite contact pressure over the whole region of the cam grooves **40, 41**. A contact pressure of the cam pins **21c, 22c** to the cam plane can be determined by a tensile force of the coil spring **254**. A most appropriate contact pressure of the cam pins **21c, 22c** is available when the coil spring **254** having an appropriate tensile force is chosen.

Thus, the cam for zooming **25** can be rotated with a definite motor driving force and the first and the second lens groups **21, 22** can be smoothly driven for moving. As a result, the cam for zooming **25** becomes a cam apparatus having a light load of small fluctuation so that a small and power saving motor can be used as a motor for zooming **26**.

Next, referring to Fig. 18, a cam for zooming **25** of this second embodiment is explained. An inner gear **42** is provided at a rear end side of the cam for zooming **25**. A protruded portion 42a of the inner gear is inserted into an inner hole of the cam base body **251**. A key **42b** provided at a circumferential portion of the protruded portion **42a** fits in a key groove **251i** formed in an inner

hole portion of the cam base body **251**. Accordingly, the cam for zooming **25** rotates together with the inner gear **42**.

The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**. The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

As a result, the cam pins **21c**, **22c** exert a definite contact pressure over the whole region of the first and second cam groove **40**, **41**; the width (L2 in Fig. 3) in a lateral direction of the image capturing unit 101 can be shortened in addition; and further the first and second lens groups **21**, **22** for zooming and the third lens group **31** are movably supported with the same guide shafts **23**, **24** so that the lens groups are difficult to fall or become eccentric.

Fig. 19 is a cross sectional drawing, which shows a driving mechanism using a cam for zooming **25** of an image capturing unit in a third embodiment. In the driving mechanism using the cam for zooming **25** of the third embodiment, an inner gear **42** is provided at a rear end side of the cam for zooming **25** as well as the second embodiment shown in Fig. 18; a protruded portion **42a** of the inner gear **42** is inserted into an inner hole of a cam base body **251**; and a key provided at the circumference portion of the protruded portion **42a** fits in a key groove formed the inner hole portion of the cam base body **251**. Accordingly, the cam for zooming **25** rotates together with the inner gear **42**. The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**. The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

Meanwhile, other cam planes **40b**, **41b** formed on cam frames **252**, **253** are slanted at a predetermined angle. This is shown in detail by a partially enlarged cross sectional drawing of the structural part of first and second cam grooves **40**, **41** and cam pins **21c**, **22c** in Fig. 20. As seen in the drawing, the other cam planes of the first and second cam frames **252**, **253** are formed

as slanting cam planes having a rising gradient to the periphery of the frame.

The cam pins **21c**, **22c** receive a pushing force in a direction of **F1** shown in the drawing because the other cam planes **40b**, **41b** are formed as slanting planes. That is, as a spring force in a direction of F2 shown in the drawing is exerted to the first and second cam fames **252**, **253** with the coil spring **254**, the first and second cam fames receive a pressing force **F1** in a direction orthogonal to the rotational axis of the cam groove in addition to the contact pressure of the cam pins **21c**, **22c** pressed by a slanting plane of the other cam planes **40b**, **41b** to the one cam plane **40a**, **41a**.

The above mentioned pressing force **F1** which acts on the cam pins affects in such a manner that hole plane portions of supporting holes **21d**, **22d** of the bosses **21b**, **22b** contacts the guide shaft **23** so as to absorb mechanical play between the supporting shaft holes **21d**, **22d** and the guide shaft **23**.

Therefore, in the cam for zooming **25**, the cam pins **21c**, **22c** contact a whole region of the first and second cam grooves **40**, **41** with a definite contact pressure and are driven to move in a direction of the rotational axis of the cam groove according to rotation of the cam for zooming **25** so that the first and second lens groups **21**, **22** move along the guide shaft **23**.

Further, since the bosses **21b**, **22b** slide the guide shaft **23** without mechanical play as mentioned above, the second lens groups **21**, **22** do not become slanting or eccentric. As a result, the driving mechanism for zooming has a cam for zooming **25** (cam apparatus) capable of upgrading zooming accuracy.

Fig. 21 (A), (B), (C) are cross sectional drawings showing other embodiments similar to Fig. 20 wherein a slanted position of the cam plane of the first and second cam grooves **40**, **41**. Fig. 21 (A) is a cross sectional drawing showing one cam planes **40a**, **41a** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (B) is a cross sectional drawing showing one cam planes **40a**, **41a** and other cam planes **40b**, **41b** of the first and second cam grooves **40**,

41, which are formed slantingly. Fig. 21 (C) is a cross sectional drawing showing other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41** and cam pins **21c**, **22c**, which are formed slantingly.

Since a pressing force **F1** acts to the cam pins **21c**, **22c** in the event of the above configuration, a play between the bosses **21b**, **22b** and the guide shaft **23** can be absorbed so that slant or eccentricity of the first and second lens groups ca be prevented. The contact portion of the cam pins **21c**, **22c**, which contact the cam plane may be formed slantingly.

Fig. 22 and 23 are another embodiment of a driving mechanism using a cam for zooming **25** of this third embodiment. Fig. 22 shows a driving mechanism in which a coil spring **45** is provided at a bearing portion **27a** of a front fixing frame **27** in order to absorb a bearing play of the cam for zooming **25**. The coil spring **45** enhances an accuracy of the moving position of the first and second lens groups **21**, **22** preventing from movement of the cam for zooming **25** in a direction of the rotational axis by pressing the cam for zooming **25** in one direction.

Next Fig. 23 shows an embodiment wherein a bearing play of the cam for zooming **25** and first and second cam frames **252**, **253** is pressed with a coil spring 46 by providing a coil spring **46** at a bearing part **27a** of a front fixing frame **27**. This embodiment is configured as such that a cam base body **251** is pressed through a cam pin **21c** by pressing a first cam frame **252** and a second cam frame **253** is pressed in one direction through a cam pin **22c**. With this configuration, a coil spring **254** hooked between the cam frames **252** and **253** becomes unnecessary.

Next, a hinge mechanism shown in Fig. 9 as **405** with which an image capturing unit **101** is connected to an operation unit **102** of an electronic camera **100** in one embodiment of the present invention. Fig. 24 is a drawing showing a configuration of a hinge mechanism only with which an image capturing unit **101** is connected to an operation unit **102** of an electronic camera **100** according to the present invention. Fig. 25 is a perspective view of connecting portion wherein the hinge mechanism is mounted to the image capturing unit **101** and an upper cover **307** and inner component parts are removed to show the connecting portion. Fig. 26 is a perspective illustration of a decomposed hinge mechanism shown in Fig. 24.

In this drawing, **500** is a hinge shaft which rotates the image capturing unit **101** with respect to the operation unit **102**; **501** is a hinge lens plate fixed on the image capturing unit **101** side and fixing a lens shaft **500**; **502** is a hinge body plate as a bearing which enables to rotate the lens shaft **500** and is fixed to the operation unit side **102**; **503** is a CE ring for fixing the shaft **500** at the hinge plate **501** side; **504** is an annular spring, which is inserted between a flange **505** of the shaft **500** and a hinge body plate **502**, has click portions at two top portions, catches recessed portion (unshown) provided on a flange **505** of the shaft **500**, and is fixed when the image capturing unit **101** rotates at an predetermined angle with respect to the operation unit **102**; and **508** is a hinge marker having a reflecting pattern **509** on its one portion for detecting a rotational angle of the image capturing unit **101** with respect to the operation unit **102** with a photo-reflector **510** by sticking to the flange portion **505** of the shaft **500**.

As shown in Fig. 25, the hinge mechanism **405** is fixed to a fixing portion **513** provided at an under cover **401** and an upper cover **307** of the image capturing unit **101** by screwing a screw through a screw hole **511** of a hinge lens plate **501**. A hinge body plate **502** is likewise fixed to a fixing portion (unshown) of an upper cover **307** and an under cover **308** of the operation unit **102**. The flange portion of the shaft **500** is stuck with the reflecting pattern **508** and the shaft is pierced in the annular spring **504**, the hinge body plate **502** and the hinge lens plate **501** and fixed to the hinge lens plate **501** with CE ring at the lens system side of the hinge lens plate **501**. The photo reflector **510** is fixed to the sub circuit board **303**.

Because of the above configuration of the hinge mechanism, the image capturing unit **101** and the operation unit **102** can rotate with a appropriate friction with the annular spring **504**; in addition, the annular spring **504** has the click portion with which it is fixed by the recessed portion (unshown) when it rotates by a predetermined angle so as to fix at a most appropriate position for photographing, for example, at a position of rotation by 90 degrees or –90 degrees. When the image capturing unit **101** rotates by -90 degrees, an image displayed on the display unit **105** is up side down. The image is correctly displayed as the photo reflector **510** detects the rotation to communicate the information of the reverse rotation to a control part of the electronic

camera **100**, whereby photographing can be performed without a sense of discomfort even if any rotation are given to the image capturing unit **101**.

As stated above diversely, the camera is designed to restrict the lens outer diameter within the thickness of the sum of each thickness of the display unit, the memory, the battery and the control circuit board, which are indispensable to recognition and record of images in electronic camera. The lens frame is a case supporting plane and the lens frame is pierced by the guide shaft so as to move back and forth. The cam for moving lens of the zoom lens is disposed at a lateral side of the lens system. These components have a thickness less than the thickness of the liquid crystal, the memory, the battery and the control circuit board. An electronic camera having a thin thickness capable of shoving in a dress shirt breast pocket or a jeans hip pocket can be offered.

Since the image capturing unit is provided with a flash unit on the side of the operation unit of a photographic window, low part of the accepting part of the flash unit is made thin, the display unit of the operation unit is disposed on the side of the image capturing unit and operating buttons are disposed on the opposite side of the image capturing unit of the display unit, the operating buttons can be disposed within the range capable of operating with a thumb when the operation unit is held with a right hand, whereby a convenient electronic camera can be offered.

Further, as operating buttons of the operation unit are provided in a plane of the case, a camera which is taken in and out smoothly if it is shoved into a breast pocket of a dress shirt or a hip pocket of a jeans can be offered.

The cam for moving the lens having a spiral cam groove cam-drives the cam pin inserted into the cam groove. Its cam driving force moves the lens. The cam for moving the lens comprises one cam body which forms one cam plane of the cam groove, another cam body provided non-rotatably and so as to be able to slide to the cam body, which forms another cam plane confronting the one cam plane, and an elastic member contacting the cam pin to the cam plane by pressing the one cam body and/or the other cam body. Thus, the cam groove is formed with the cam plane of the one cam body and the cam plane of the other cam body, and the cam pin

inserted into the cam groove contacts cam plane by the spring member pressing these cam body, whereby the electronic camera having the cam apparatus the cam pin of which contacts the cam plane with a definite contact pressure over the whole range of the cam groove can be made.

Further, the cam for moving the lens comprises the cam base body having the sliding portions with a smaller diameter at the both ends of a cylinder, the stepped portion between the one sliding portion and the middle portion of the cylinder as one cam plane of the first cam groove, and the stepped portion between the other sliding portion and the middle portion of the cylinder as one cam plane of the second cam groove; the first cam frame having the other cam plane confronting the one cam plane of the first cam groove and provided non-rotatably to the one sliding portion so as to be able to slide; the second cam frame provided non-rotatably to the other sliding portion so as to be able to slide; and the elastic member which makes each cam pin inserted into the two cam grooves formed with the first and the second cam frame and the cam base body contact the cam plane by pressing the first and the second cam frames. Thus, the cam grooves are formed by the one cam plane of the one cam body and the other cam plane of the other cam body and the cam groove inserting member inserted into the cam groove presses the cam plane by spring force action of the spring member pressing the one cam body and/or the other cam body.

Further, the cam for moving the lens comprises the cam base body having the sliding portions with a smaller diameter at the both ends of a cylinder, the stepped portion between the one sliding portion and the middle portion of the cylinder as one cam plane of the first cam groove, and the stepped portion between the other sliding portion and the middle portion of the cylinder as one cam plane of the second cam groove; the first cam frame having the other cam plane confronting the one cam plane of the first cam groove and provided non-rotatably to the one sliding portion so as to be able to slide; the second cam frame provided non-rotatably to the other sliding portion so as to be able to slide; and the elastic member which makes each cam pin inserted into the two cam grooves formed with the first and the second cam frame and the cam base body contact the cam plane by pressing the first and the second cam frames. Thus, the cam grooves are formed by the one cam plane of the one cam body and the other cam plane of the

other cam body and the cam groove inserting member inserted into the cam groove presses the cam plane by spring force action of the spring member pressing the one cam body and/or the other cam body.

Yet further, the cam for moving the lens comprises the first cylinder on which the sliding portion with a smaller diameter having one cam plane of the first cam groove is disposed, the second cylinder on which the sliding portion with a smaller diameter having one cam plane of the second cam groove is disposed non-rotatably to the first cylinder, the first cam frame which forms the other cam plane confronting the one cam plane of the first cam groove and is provided non-rotatably so as to be able to slide at the sliding portion of the first cylinder, the second cam frame which forms the other cam plane confronting the one cam plane of the second cam groove and is provided non-rotatably so as to be able to slide at the sliding portion of the second cylinder, and the elastic member which cause the each cam pin inserted into the two cam grooves formed by the first and the second cam frames and the cam base body to the cam plane by pressing these first and second cam frames, wherein the cam grove is formed by one cam plane of one cam body and another cam plane of another cam body, and the cam inserting member inserted into the cam groove contact the cam plane by the spring force of the spring member which presses the one cam body and/or the other cam body.

Therefore, the contact pressure of the cam groove inserting member against the cam plane is determined by the spring force of the spring member pushing the cam body so that there is an even contact pressure over whole region of the cam groove. As a result, the cam shaft does not shift to generate no fluctuation of the right moving position of the moving object. As the slanting portion is provided on the cam plane contacting the cam groove inserting member, the cam groove inserting member receives the cam driving force in a direction of the rotational axis of the cam groove together with the pushing force in a direction orthogonal to the rotational axis. More specifically, as the cam groove inserting member receives the above mentioned pushing force by rotation of the cam groove, the electronic camera having the cam apparatus in which the moving object closely contacts the guide shaft and mechanical play between the moving object and the guide shaft is absorbed can be offered.

The first and second cam frames can be pressed with one coil spring by providing the stretching coil spring one end of which is hooked to the first cam frame and the other end of which is hooked to the second cam frame as said elastic member.

As the slanting portion is provided on the cam plane contacting the cam groove inserting member, the cam groove inserting member receives the cam driving force in a direction of the rotational axis of the cam groove together with the pushing force in a direction orthogonal to the rotational axis.. More specifically, as the cam groove inserting member receives the above mentioned pushing force by rotation of the cam groove, the moving object closely contacts the guide shaft and a mechanical play between the moving object and the guide shaft is absorbed.

The slanting portion provided on at least one of the one cam plane and the other cam plane preferably has a slanting plane which gives the cam groove inserting member a cam driving force in a direction of the rotational axis of the cam groove and a pressing force in a direction orthogonal to the rotational axis.

One spring member can press the first and second cam frames by the elastic member being the spring member pressing the first and second cam frames and the cam base body or the first cylinder and the second cylinder in one direction.

Since the tensile spring member one end of which is hooked to the first cam frame and the other end of which is hooked to the second cam frame, and the spring member pressing the first and second cam base body in one direction are provided as the elastic members, the cam pin is pressed to the cam plane and the whole cam apparatus is pressed in one direction by pressing the cam base body and the whole body of the first and second cam frame with the spring members, which leads to absorbing a mechanical play of the rotational shaft portion of the cam apparatus.

Thus, the camera is designed to restrict the lens outer diameter within the thickness of the sum of each thickness of the display unit, the memory, the battery and the control circuit board, which

are indispensable to recognition and record of images in electronic camera. The lens frame is a case supporting plane and the lens frame is pierced by the guide shaft so as to move back and forth. The cam for moving lens of the zoom lens is disposed at a lateral side of the lens system. These components have a thickness less than the thickness of the liquid crystal, the memory, the battery and the control circuit board. An electronic camera having a thin thickness capable of shoving in a dress shirt breast pocket or a jeans hip pocket can be offered.

Since the image capturing unit is provided with a flash unit on the side of the operation unit of a photographic window, low part of the accepting part of the flash unit is made thin, the display unit of the operation unit is disposed on the side of the image capturing unit and operating buttons are disposed on the opposite side of the image capturing unit of the display unit, the operating buttons can be disposed within the range capable of operating with a thumb when the operation unit is held with a right hand, whereby a convenient electronic camera can be offered.

Further, as operating buttons of the operation unit are provided in a plane of the case, a camera which is taken in and out smoothly if it is shoved into a breast pocket of a dress shirt or a hip pocket of a jeans can be offered.

In order to attain a thin optical system, the shutter provided in the optical system of the image capturing unit is preferably square shaped having the same height as that of the lens frame.

The cam for moving the lens having a spiral cam groove cam-drives the cam pin inserted into the cam groove. Its cam driving force moves the lens. The cam for moving the lens comprises one cam body which forms one cam plane of the cam groove, another cam body provided non-rotatably and so as to be able to slide to the cam body, which forms another cam plane confronting the one cam plane, and an elastic member contacting the cam pin to the cam plane by pressing the one cam body and/or the other cam body. Thus, the cam groove is formed with the cam plane of the one cam body and the cam plane of the other cam body, and the cam pin inserted into the cam groove contacts cam plane by the spring member pressing these cam body, whereby the electronic camera having the cam apparatus the cam pin of which contacts the cam

plane with a definite contact pressure over the whole range of the cam groove can be made.

Further, the cam for moving the lens comprises the cam base body having the sliding portions with a smaller diameter at the both ends of a cylinder, the stepped portion between the one sliding portion and the middle portion of the cylinder as one cam plane of the first cam groove, and the stepped portion between the other sliding portion and the middle portion of the cylinder as one cam plane of the second cam groove; the first cam frame having the other cam plane confronting the one cam plane of the first cam groove and provided non-rotatably to the one sliding portion so as to be able to slide; the second cam frame provided non-rotatably to the other sliding portion so as to be able to slide; and the elastic member which makes each cam pin inserted into the two cam grooves formed with the first and the second cam frame and the cam base body contact the cam plane by pressing the first and the second cam frames. Thus, the cam grooves are formed by the one cam plane of the one cam body and the other cam plane of the other cam body and the cam groove inserting member inserted into the cam groove presses the cam plane by spring force action of the spring member pressing the one cam body and/or the other cam body.

Yet further, the cam for moving the lens comprises the first cylinder on which the sliding portion with a smaller diameter having one cam plane of the first cam groove is disposed, the second cylinder on which the sliding portion with a smaller diameter having one cam plane of the second cam groove is disposed non-rotatably to the first cylinder, the first cam frame which forms the other cam plane confronting the one cam plane of the first cam groove and is provided non-rotatably so as to be able to slide at the sliding portion of the first cylinder, the second cam frame which forms the other cam plane confronting the one cam plane of the second cam groove and is provided non-rotatably so as to be able to slide at the sliding portion of the second cylinder, and the elastic member which cause the each cam pin inserted into the two cam grooves formed by the first and the second cam frames and the cam base body to the cam plane by pressing these first and second cam frames, wherein the cam grove is formed by one cam plane of one cam body and another cam plane of another cam body, and the cam inserting member inserted into the cam groove contact the cam plane by the spring force of the spring member which presses

the one cam body and/or the other cam body.

Therefore, the contact pressure of the cam groove inserting member against the cam plane is determined by the spring force of the spring member pushing the cam body so that there is an even contact pressure over whole region of the cam groove. As a result, the cam shaft does not shift to generate no fluctuation of the right moving position of the moving object. As the slanting portion is provided on the cam plane contacting the cam groove inserting member, the cam groove inserting member receives the cam driving force in a direction of the rotational axis of the cam groove together with the pushing force in a direction orthogonal to the rotational axis. More specifically, as the cam groove inserting member receives the above mentioned pushing force by rotation of the cam groove, the electronic camera having the cam apparatus in which the moving object closely contacts the guide shaft and a mechanical play between the moving object and the guide shaft is absorbed can be offered.

The first and second cam frames can be pressed with one coil spring by providing the stretching coil spring one end of which is hooked to the first cam frame and the other end of which is hooked to the second cam frame as said elastic member.

As the slanting portion is provided on the cam plane contacting the cam groove inserting member, the cam groove inserting member receives the cam driving force in a direction of the rotational axis of the cam groove together with the pushing force in a direction orthogonal to the rotational axis. More specifically, as the cam groove inserting member receives the above mentioned pushing force by rotation of the cam groove, the moving object closely contacts the guide shaft and a mechanical play between the moving object and the guide shaft is absorbed.

The slanting portion provided on at least one of the one cam plane and the other cam plane preferably has a slanting plane which gives the cam groove inserting member a cam driving force in a direction of the rotational axis of the cam groove and a pressing force in a direction orthogonal to the rotaional axis.

One spring member can press the first and second cam frames by the elastic member being the spring member pressing the first and second cam frames and the cam base body or the first cylinder and the second cylinder in one direction.

Since the tensile spring member one end of which is hooked to the first cam frame and the other end of which is hooked to the second cam frame, and the spring member pressing the first and second cam base body in one direction are provided as the elastic members, the cam pin is pressed to the cam plane and the whole cam apparatus is pressed in one direction by pressing the cam base body and the whole body of the first and second cam frame with the spring members, which leads to absorbing mechanical play of the rotational shaft portion of the cam apparatus.

Thus, according to this embodiment, the camera is designed to restrict the lens outer diameter within the thickness of the sum of each thickness of the display unit, the memory, the battery and the control circuit board, which are indispensable to recognition and record of images in electronic camera. The lens frame is a case supporting plane and the lens frame is pierced by the guide shaft so as to move back and forth. The cam for moving lens of the zoom lens is disposed at a lateral side of the lens system. These components have a thickness less than the thickness of the liquid crystal, the memory, the battery and the control circuit board. An electronic camera having a thin thickness capable of shoving in a dress shirt breast pocket or a jeans hip pocket can be offered.

Second Embodiment

Fig. 1 is an over all view of an electronic camera in this embodiment. Fig. 2 is an illustration of an electronic camera in this embodiment, which shows a photographing state in case a lens is targeted to an object. Fig. 3 is an illustration of an electronic camera in this embodiment, which shows a photographing state in case a lens is targeted to a photographer, him or herself. Fig. 4 is an illustration of an electronic camera in this embodiment, which shows a held state in case a lens is targeted to an object.

In the drawings, **100** is an electronic camera in this embodiment. **101** is an image capturing

unit , 102 is an operation unit, 103 is a photographic lens window, 104 is a flash unit window such as a strobe, 105 is a display unit using such as LCD, 106 is a shutter button, 107 is a power button, 108 is a selection and decision key for selecting a function or an item which is displayed on the display unit **105** comprising a cross key and a decision key, 109 is a zoom key which bids optical system zooming and a menu button which changes on and off of a camera mode menu respectively. **111** is a display button, which changes on and off of display contents and light, and 112 is a scene button, which changes a display content of the display unit **105** to a scene selecting screen page respectively. **113** is a mode selecting button which select modes such as an aperture priority mode, a shutter priority mode, sports mode for photographing rapidly moving objects, a macro mode for photographing near objects, strobe control of enforced flashing of strobe or flashing halt, movie shooting and movie play back. **114** is a speaker.

In an electronic camera **100** in this embodiment, as shown in Fig. 1-3, display unit **105**, general operational buttons for photographing **106-113** are disposed on the operation unit **102** side to which the image capturing unit **101** is connected rotatably by a hinge mechanism. The photographic lens window **103** is disposed on one side of the image capturing unit **101** and the flash unit window **104** is disposed on the operation unit **102**. The operational buttons for photographing **106-113** are provided on the operation unit so as no to project from the surface of the outer cover of the operation unit whereby making one no sense of discomfort or getting hooked when shoving in a breast pocket of a dress shirt or in a hip pocket of jeans. Further, the shutter button **106** is positioned so as to be operable with a pointing finger when the camera 100 is held with a right hand. Further, the shutter button **106** is positioned so as to be operable with a pointing finger when the camera **100** is held with a right hand. The zoom key **109**, the selection and decision key **108**, the menu button **110**, and the mode selecting button **113** are likewise disposed within the reaching distance for a thumb finger when the camera **100** is held with a right hand whereby operationality is upgraded.

Further, in the electronic camera **100** of this embodiment, when a length L1 between the end of the photographic window **103** side and the end of the flash unit window **104** side of the image capturing unit **101** be, for example, a length between a tip of a forefinger of a left hand and near a

second arthrosis of the finger, and a length of a reverse side of the photographic lens window be L2, a thickness L3 along a direction of an optical axis of a portion of the flash unit window **104** corresponding to the portion L1-L2 is a thickness of a forefinger and the portion is roundly flared to the operation unit **102** side (see Fig. 3). Thus, a space for disposing operational buttons at the right side of the display unit **105** of the operation unit **102** is secured, whereby the electronic camera can be made small and of a good operationality.

When the electronic camera **100** is used, a power button **107** is pushed to activate the power and each button is operated. Any mode is selected by the menu button **110** with the mode selecting button **113** such as a photographing condition of an aperture priority mode or of a shutter priority mode, a sports mode photographing a body moving rapidly, a macro mode which photographs near objects, a strobe control of enforced flashing or flashing halt, and a movie shooting or movie play back. An item is selected by the selection and decision key **108** comprising a cross key and decision key and decided by pushing a center decision button as needed after displaying a variety of menus such as a size of an image, a photographic sensitivity, and a photometry method on the display unit **105** by pushing the menu button **110**.

When the photographic window is pointed at a object as shown in Fig. 2, the operation unit **102** is held with a right hand as shown in Fig. 4 and a portion of L3 (see Fig. 3) of the image capturing unit **101** having a length of L1 (see Fig. 3) is held with a fore finger and a middle finger and the photographic window **103** is pointed at the object. After a predetermined magnification is determined by operating the zoom key **109** of the image capturing unit **101** with a thumb of the right hand while seeing a object displayed on the display unit **105**, the shutter button **106** is pushed with a forefinger of the right hand to automatically determine exposure and focus so that a captured image signal by a built-in image capturing element such as CCD is stored in a built-in memory. By photographing in this way, since a distance between the photographic lens window **103** of the image capturing unit **101** and the rotational center of the hinge mechanism is greater than a distance between the rotational center of the hinge mechanism and an end of a reverse side to the photographic window **103**, a lens unit is largely rotated so that the image capturing unit can be rapidly pointed at an object and the camera **100** can be held

tightly.

Further, in the electronic camera **100** of this embodiment, a self-portrait can be taken by pointing the photographic lens window **103** of the image capturing unit **101** is pointed at a camera operator not only at an object. In this case, since a distance between the photographic lens window **103** side of the image capturing unit **101** and a rotational center of the hinge mechanism is made greater than a distance of the reverse side, though the flared portion, where a window for the flash unit **104** of the image capturing unit **101** is disposed, covers a part of the display unit **105**, photographing a self-portrait is possible while confirming an image on the screen by the display unit **105**.

After thus photographing, when a mode is turned to a playback mode with a mode selecting button **113**, an image signal stored in the memory is displayed on the display unit **105** and captured images can be sequentially displayed on the display unit by operating the cross key of the selection and decision key **108**. In case of a movie shooting mode, a movie signal is stored in a memory and is played back together with sound at the same time from the speaker **114** by selecting a necessary scene with the scene button **112**.

Thus, in the electronic camera **100** of this embodiment, since the opposite side of the photographic lens window **103** of the image capturing unit **101** can be made thin by the flash unit **104** window being disposed so that the photographic lens window **103** side of the image capturing unit **101** is flared to the operation unit **102** side, a whole camera size can be made the smaller. Further, since the lens can be pointed at an object with a little rotational action by a distance between the photographic lens window **103** side of the image capturing unit **101** and a rotational center of the hinge mechanism being made greater than a distance of the reverse side, a convenient electronic camera can be offered.

As a thickness of the flared portion of the image capturing unit 101 in a direction of the optical axis is approximately equal to a thickness of a finger and a distance between the end of the photographic lens window **103** side and the end of the flared portion side is approximately equal

to a length between a tip of a finger and the second arthrosis of the finger, the flared part can be held with two fingers for rotating. Thus, since the operation unit 102 of the electronic camera in this embodiment can be held with the right hand and the flared portion is held with the fore finger and the middle finger of the left hand to point at an object, the camera can be held firmly in the event of photographing and a convenient electronic camera can be offered.

The distance between the photographic lens window **103** side of the image capturing unit **101** and rotational center of the hinge mechanism is such distance that visibility of the display unit **105** is not hindered by the flared portion. Thus, since visibility of the display unit **105** is not hindered even when a camera operator photographs him or herself, an electronic camera capable of easily shooting a self-portrait can be offered.

Further, The opposite side of the photographic lens window **103** in the image capturing unit **101** can be made narrow, by the window of the flash unit **104** being disposed in the flared portion of the image capturing unit **101** of the photographic lens window **103** side.
Thus, since the display unit of the operation unit is disposed at the image capturing unit side and the operating buttons can be disposed at the opposite side of the image capturing unit of the display unit, a convenient electronic camera **100** wherein the display unit can be seen while the operating buttons are operated can be offered.

Further according to this embodiment, in an electronic camera comprising an operation unit having a display unit and an image capturing unit connected rotatably to the operation unit by a hinge mechanism and provided with a flash unit and a photographic zoom lens for communicating an image to the display unit, the photographic window side of the image capturing unit is flared to the operation side for disposing the flash unit and the distance between the photographic window side and the rotational center of the hinge mechanism is greater than that of the opposite side.

When the photographic window side of the image capturing unit is thus flared to the operation side and the flash unit is disposed, the side opposite to the photographic lens in the image

capturing unit can be made thin so that the whole camera size becomes small. Further, because the distance between the photographic window side and the rotational center of the hinge mechanism is greater than that of the opposite side, the lens can be targeted at an object with a small rotational action in the image capturing unit so that a convenient electronic camera is provided.

A thickness of the flared portion of the image capturing unit in a direction of the optical axis is approximately equal to a thickness of a finger and a distance between the end of the photographic lens window side and the end of the flared portion side is approximately equal to a length between a tip of a finger and the second arthrosis of the finger so that the flared part can be held with two fingers for rotating. Thus, since the operation unit of the electronic camera in this embodiment can be held with the right hand and the flared portion is held with the fore finger and the middle finger of the left hand to point at an object, the camera can be held firmly in the event of photographing and a convenient electronic camera can be offered.

The distance between the photographic lens window side of the image capturing unit and rotational center of the hinge mechanism is such distance that visibility of the display unit is not hindered by the flared portion. Thus, since visibility of the display unit is not hindered even when a camera operator photographs him or herself, an electronic camera capable of easily shooting a self-portrait can be offered.

Further, The opposite side of the photographic lens window in the image capturing unit can be made narrow, by the window of the flash unit being disposed in the flared portion of the image capturing unit of the photographic lens window side. Thus, since the display unit of the operation unit is disposed at the image capturing unit side and the operating buttons can be disposed at the opposite side of the image capturing unit of the display unit, a convenient electronic camera wherein the display unit can be seen while the operating buttons are operated can be offered.

As described above, according to this embodiment, since the opposite side of the image

capturing unit **101** to the photographic lens window **103** side can be made narrow by disposing the flash unit **104** at the flared to the operation unit **102** portion of the photographic lens window **103** side of the image capturing unit **101**, the whole electronic camera **100** size can be made the smaller. In addition, since a distance between the photographic lens window **103** side and the rotational center of the hinge mechanism is made greater than that of the opposite side, the image capturing unit **101** can be pointed at an object by a little rotational action so that a convenient electronic camera can be offered.

Third Embodiment

As a rate reducing device comprises an integrated gear configuration having a lot of rate reducing gears for a interlocking system of a power mechanism such as a cam or lead screw and a motor, the smaller or the thinner becomes a camera form, the more complicated becomes a gear configuration because of restriction of the space for mounting and disposing the rate reducing device.

Further, as rate reducing device becomes big when a lot of rate reducing gears are integrally disposed, a mounting space of the rate reducing device becomes a problem particularly when a camera is made thin, which leads to a limited miniaturisation of a camera.

The object of this embodiment is to propose a camera and an optical zoom mechanism provided with a rate reducing device capable of mounting even in a small or thin camera in view of the above mentioned actual situation.

Now, a third embodiment according to the present invention is explained referring to the drawings as follows.

Fig. 27 is a perspective illustration showing one embodiment of a driving mechanism for zooming. Fig. 28 is a front elevational view of the above driving mechanism for zooming.

In the drawings, **21** is a first lens group and **22** is a second lens group. The first and second lens frames **21**, **22** are supported by a guide shaft **23** which is pierced so as to be able to slide to a boss **21b** provided on a lens frame **21a** and to a boss **22b** provided on a lens frame **22a**.

Holes are provided at the opposite position to the bosses **21b**, **22b** on the lens frames **21a**, **22a** and a guide shaft **24** is pierced to these holes so as to be able to slide to prevent rotation of the lens groups **21**, **22**.

Further, a cam pin (a cam groove inserting member) **21c** of the first lens group **21** formed projectingly on the above boss **21b** and a cam pin (a cam groove inserting member) **22c** of the second lens group **22** formed projectingly on the boss **22b** are inserted into the cam groove of the cam for zooming **25** so that the first and second lens groups are cam driven along the optical axis according to rotation of the cam for zooming **25**(see Fig. 29). The cam for zooming **25** is rotatively driven by a motor for zooming **26**

One end of the guide shaft **23**, **24** is fixed to a front fixing frame **27** and another end is fixed to a rear fixing frame **28**. The cam for zooming **25** is rotatably supported by a bearing portion **27a** of the front fixing frame **27** and a bearing portion **29a** (see Fig. 18) of a supporting fixing frame **29** fixed to the rear fixing frame **28**.

Window holes **27b**, **28a** through which object image light passes are formed on the front fixing frame **27** and the rear fixing frame **28**. Further, a CCD (an solid image forming element) is mounted in right after the window of the rear fixing frame **28** (see Fig. **27**, **29**).

While, a third lens group 31 shown in Fig. **27** is a lens for focusing and is supported by piercing the guide shaft **23** to a boss **31a** provided on the lens frame **31a**. The third lens group **31** is screw-driven by a lead screw **34** rotatively driven with a motor for focusing **33** to advance and retreat along the optical axis.

Besides, referring to Fig. 27, **35** is a shutter unit fixed to the lens frame **22a**; **36** is a cover plate;

37 is a photo interrupter for zooming; **38** is a photo interrupter for focusing; and **39** is a spring for preventing a play of the third lens group **31**, the spring which presses the boss in one direction to absorb the play between the lead screw **34** and a nut **32**. The photo interrupter for zooming **37** detects an initial position for zooming and the photo interrupter for focusing detects an initial position for focusing.

In the above configured driving mechanism for zooming of the photographic lens, the first and second lens group **21**, **22** moves for zooming by driving rotatively the cam for zooming **25** with the motor for zooming **26** and the third lens group **31** moves for focusing by driving rotatively the lead screw **34** to screw-drive the nut screw **32**.

In addition, the third lens group **31** also moves at the time of zooming.

The cam **25** for zoom with which the above mentioned driving mechanism for zooming **20** is equipped as a cam apparatus on the other hand is explained with reference to Fig. 29, Fig. 30, and Fig. 31.

Fig. 31 is the same perspective illustration of a cam for zooming as Fig. 27 when the third lens group, the motor for focusing **33**, the shutter unit **35**, the cover plate **36** and so on are removed for showing. Fig. 30 is a perspective illustration of a cam for zooming **25**. Fig. 31 is an exploded perspective illustration of a cam for zooming.

As shown in the drawing, the cam **25** for zooming is a cylindrical cam having a first cam groove **40** and a second cam groove **41** and comprises a cylindrical cam base body **251**, cylindrical cam frames **252**, **253** which fit the both sides of the cam base body **251** so as to be able to slide, and a tensile coil spring **254** pressing the cam frames **252**, **253** in a direction for approaching each other.

A cam base body **251** has a sliding portions **251b**, **251c** having a smaller portion at the both sides of the middle portion **251a**. One cam plane **40a** is formed for forming a first cam groove **40** at a stepped portion between the middle portion **251a** and the sliding portion **251b**. One cam plane **41a** is formed for forming a first cam groove **41** at a stepped portion between the middle portion **251a** and the sliding portion **251c**.

The cam base body **251** has long holes **251d, 251e** along an axial direction from the both ends, into which protruded portions **252a**, **253a** are fit so as to be able to slide, whereby the cam frames **252, 253** are rotated together with the cam base body **251**. A hole portion **251f** formed at the ends of sliding portion **251b, 251c** is to attach a coil spring **254**. Stepped portions **251g, 251h** are to restrict movement of a cam frame **252, 253.**

Meanwhile, a cam frame **252** has another cam plane **40b** for forming a first cam groove **40** at one end circumference portion and further has a pointing inner flange **252b**. The cam frame **252** has a spring hooking portion **252c** projected from the protruded portion **252a** in the cylinder.

A cam frame **253** has another cam plane **41b** for forming a first cam groove **41** at one end circumference portion and further has a pointing inner flange **253b**. The cam frame **253** has a spring hooking portion **253c** projected from the protruded portion **253a** in the cylinder.

With regard to the cam base body **251**, the cam frames **252**, and **253**, after the cam frame **252** is fit to the sliding portion **251b** of the cam base body **251** and the cam frame **253** is fit to the sliding portion **251c**, one end of coil spring **254** is hooked to the spring hooking portion **252c** of the cam frame **252** and another end is hooked to the spring hooking portion **253c** of the cam frame **253**.

Then the coil spring **254** presses the cam frame **252** and **253** in a direction of approaching each other so that the flange portion **252b** advances until it strikes the stepped portion **251g** as the cam frame **252** slides the sliding portion **251b**. With this state, the first cam groove is formed by the one cam plane **40a** and the other cam plane **40b**.

Likewise, the cam frame **253** slides the sliding portion **251c** and the flange portion **253b** advances until it strikes the stepped portion **251h** so that the second cam groove is formed by the one cam plane **41a** and the other cam plane **41b** with this state.

Thus formed cam grooves **40, 41** become spring shaped cam grooves matched with

movement of the first and second lens groups **21**, **22** necessary to zooming.

As shown in Fig. 29, in the cam for zooming 25 configured as described above, the cam pin **21c** of the first lens group **21** is inserted into the cam groove **40** and the cam pin **22c** of the second lens group **22** is inserted into the cam groove **41**. By the insertion of the cam pins **21c**, **22c** like this way, the flange portion **252b** of the cam frame **252** retreats a little from the stepped portion **251g** and likewise, the flange portion **253b** of the cam frame **253** retreats a little from the stepped portion **251h**.

Therefore, since the cam pin **21c** is pressed to the cam plane **40b** of the cam frame **252** and the cam pin **22c** is pressed to the cam plane **41b** of the cam frame **253**, the cam pins **21c**, **22c** contact to the cam plane with a definite contact pressure over the whole region of the cam grooves **40**, **41**. A contact pressure of the cam pins **21c**, **22c** to the cam plane can be determined by a tensile force of the coil spring **254**. A most appropriate contact pressure of the cam pins **21c**, **22c** is available when the coil spring **254** having an appropriate tensile force is chosen.

Thus, the cam for zooming **25** can be rotated with a definite motor driving force and the first and the second lens groups **21**, **22** can be smoothly driven for moving. As a result, the cam for zooming **25** becomes a cam apparatus having a light load of small fluctuation so that a small and power-saving motor can be used as a motor for zooming **26**.

Fig. 18 is a cross sectional drawing showing a cross section of the cam for zooming **25** and its driving system by cutting by the A-A line of Fig. 28.

As shown in the drawing, a cam for zooming **25** of this second embodiment is explained. An inner gear **42** is provided at a rear end side of the cam for zooming **25**. A protruded portion 42a of the inner gear is inserted into an inner hole of the cam base body **251**. A key **42b** provided at a circumferential portion of the protruded portion **42a** fits in a key groove **251i** formed in an inner hole portion of the cam base body **251**.

Accordingly, the cam for zooming **25** rotates together with the inner gear **42**.

The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**.

The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

In the driving mechanism for zooming **20** carried out as above, the cam pins **21c**, **22c** exert a definite contact pressure over the whole region of the first and second cam groove **40**, **41**; the width in a lateral direction of the camera (width in a direction of left and right in Fig. 28) can be shortened in addition; and further the first and second lens groups **21**, **22** for zooming and the third lens group **31** are movably supported with the same guide shafts **23** so that the lens groups are difficult to fall or become eccentric.

Fig. 19 shows a driving mechanism for zooming **50** of the second embodiment.

The driving mechanism for zooming **50** is characterized in that the other cam planes **40b**, **41b** formed on the cam frames **252**, **253** are slanted at an predetermined angle, though, other features are the same as the driving mechanism for zooming **20** shown in Fig. 27-28.

Fig. 19 corresponds to a cross sectional view by the b-b line in Fig. 28.

Fig. 20 is a Fig. 20 is a partially enlarged cross sectional drawing showing a configured portion formed by the first and second cam grooves **40**, **41** together with the cam pins **21c**, **22c**. As seen in the drawing, the other cam planes of the first and second cam frames **252**, **253** are formed as slanting cam planes having a rising gradient to the periphery of the frame.

The cam pins **21c**, **22c** receive a pushing force in a direction of **F1** shown in the drawing because the other cam planes **40b**, **41b** are formed as slanting planes. That is, as a spring force in a direction of **F2** shown in the drawing is exerted to the first and second cam fames **252**, **253** with the coil spring **254**, the first and second cam fames receive a pressing force **F1** in a direction orthogonal to the rotational axis of the cam groove in addition to the contact pressure of the cam pins **21c**, **22c** pressed by a slanting plane of the other cam planes **40b**, **41b** to the one cam plane **40a**, **41a**.

The above mentioned pressing force **F1** which acts on the cam pins affects in such a manner that hole plane portions of supporting holes **21d**, **22d** of the bosses **21b**, **22b** (see Fig.20) contacts the guide shaft **23** so as to absorb mechanical play between the supporting shaft holes **21d**, **22d** and the guide shaft **23**.

In the cam for zooming **25** as configured above, the cam pins **21c**, **22c** contact a whole region of the first and second cam grooves **40**, **41** with a definite contact pressure and are driven to move in a direction of the rotational axis of the cam groove according to rotation of the cam for zooming **25** so that the first and second lens groups **21**, **22** move along the guide shaft **23**.

Further, since the bosses **21b**, **22b** slide the guide shaft **23** without mechanical play as mentioned above, the second lens groups **21**, **22** do not become slanting or eccentric. As a result, the driving mechanism for zooming has a cam for zooming **25** (cam apparatus) capable of upgrading zooming accuracy.

Fig. 21 (A), (B), (C) are cross sectional drawings showing other embodiments similar to Fig. 20 wherein a slanted position of the cam plane of the first and second cam grooves **40**, **41**. Fig. 21 (A) is a cross sectional drawing showing one cam planes **40a**, **41a** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (B) is a cross sectional drawing showing one cam planes **40a**, **41a** and other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (C) is a cross sectional drawing showing other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41** and cam pins **21c**, **22c**, which are formed slantingly.

Since a pressing force **F1** acts to the cam pins **21c**, **22c** in the event of the above configuration, play between the bosses **21b**, **22b** and the guide shaft **23** can be absorbed similarly to the embodiment shown in Fig. 20 so that slant or eccentricity of the first and second lens groups **21**, **22** can be prevented.

Further, when the both cam planes are formed slantingly as shown in Fig. 21 (B), smoother zooming action can be realized compared to the one with one slanted cam plane.

Also in the embodiment shown in Fig. 20, Fig. 21 (A), (B), the contact portion of the cam pins **21c**, **22c**, which contact the cam plane may be formed slantingly.

Fig. 22 shows another embodiment of a driving mechanism using a cam for zooming **25** of this third embodiment. Fig. 22 shows a driving mechanism in which a coil spring **45** is provided at a bearing portion **27a** of a front fixing frame **27** in order to absorb a bearing play of the cam for zooming **25**. The coil spring **45** enhances an accuracy of the moving position of the first and second lens groups **21**, **22** preventing from movement of the cam for zooming **25** in a direction of the rotational axis by pressing the cam for zooming **25** in one direction.

Fig. 23 shows an embodiment wherein a bearing play of the cam for zooming **25** and first and second cam frames **252**, **253** is pressed with a coil spring 46 by providing a coil spring **46** at a bearing part **27a** of a front fixing frame **27**.

This embodiment is configured in such a manner that a cam base body **251** is pressed through a cam pin **21c** by pressing a first cam frame **252** and a second cam frame **253** is pressed in one direction through a cam pin **22c**. With this configuration, a coil spring **254** hooked between the cam frames **252** and **253** becomes unnecessary.

Fig. 32-34 show a zooming mechanism similar to the zooming mechanism **20** or **50** described above for a lens barrel less electronic camera (digital camera) having no lens barrel as an example.

Fig. 32 is a camera plan view. Fig. 33 is a camera front elevational view. Fig. 34 is a camera rear elevation view of an electronic camera shown in Fig. 32.

As shown in the drawings, the electronic camera has a form having a big longitudinal and transversal width and a small depth in a front view so that the camera is thin.

The electronic camera has two separate box-like bodies as a camera main body **60** provided with a controller, a memory card, a computing part, a memory card slot and others and as an

optical system installed part 61 provided with a photographic lens and others.

And the camera main body **60** is rotatably within reasonable bounds coupled with the optical system installed part **61** by a coupling part **62**.

As shown in the drawing, on the upper plane of the camera main body **60**, a shutter button and a power switch are provided; on the back plane of the camera main body **60**, a liquid crystal monitor **65**, selection and decision button **66**, a zoom button **67**, mode selecting button **68** and others are provided; further, various circuit boards including a CPU, a battery which supplies electric power, a memory card slot are installed in the camera main body **60**(unshown).

Further, a photographic lens window **69** and a flash window of a flash unit **70** are provided on the upper plane of the optical system installed part **61**,and a zooming mechanism part **20**, **50**, **90** and a flash unit **80** stated later are installed by shielding light in the optical system installed part **61**.

Thus, while disposing a display unit, an operation unit, a battery, a memory card slot, and a circuit board in the camera main body **60**, thin shape of the whole camera is realized by integrating an optical mechanism and the flash unit **80** in the optical system installed part **61**.

Since the above mentioned electronic camera is a very thin type of camera, it is convenient to carry.

On the other hand, when taking a photograph, as shown in Fig. 35 for example, the optical system installed part **61** is rotated so that the photographic lens window **69** points at the front.

Since the camera main body **60** is grasped by hand and the shutter can be released in this state, the camera shake scarcely occurs with this camera.

Moreover, as the optical system installed part **61** can be rotated to an opposite side to that shown in Fig. 35, it can be pointed at the same direction as the liquid crystal monitor **65** for photographing.

Fig. 36 is a perspective illustration of an optical system installed part **61** when a rear case is removed. Fig. 37 is a transverse sectional view of the above optical system installed part. Fig. 38

is an exploded perspective illustration of the above optical system installed part **61**.

As seen in these drawings, the optical system installed part **61** has a flash unit **80** and a driving mechanism for zooming (a optical system unit) **90** of photographic lenses mounted in a box like front case (camera case) **71** so as to be a lens barrel less type having no lens barrel. The above units and others are installed by shielding light.

Therefore, the optical system installed part **61** is restricted to a thickness defined by a height of the optical unit which formed thin so that a thin type of camera is realized.

The flash unit **80** resides in the innermost portion of the flash part **81** and the front case **71** and has a main condenser **82** disposed adjacently at the rear of the optical system unit and a circuit board **83** at the side of the optical system unit in the front case **71**.

The driving mechanism for zooming **90** is disposed in the frond case **71** by screwing with small screws **91**. A photographing image light enters in an image capturing optical system consisting of the first, second and third lens groups **21**, **22**, **31** through the photographic lens window **69**.

In addition, the cover 92 which prevents invasion of solder waste, dust, and others is provided on the driving mechanism for zooming **90**.

As mentioned above, the rear case **72** is fixed with a screw to the front case **71** to which the flash unit **80** and driving mechanism for zooming **90** are mounted.

More particularly, as shown in Fig. 38, the rear case **72** is fixed to the front case **71** with the small screw **93** which is inserted into the one side of the rear case **72** from the front case **71**. The other side of the rear case **72** is screwed with the one side of a tongue flange **62a** of the coupling part **62**.

That is, the one side of the tongue flange **62** of the coupling part **62** is fixed with a small screw **73** to the front case **71** and rear case **72** so as to unite together.

In addition, the other side of the tongue flange **62b** of the coupling part **62** is screwed to the case of the camera main body **60**, with a tubular portion **62c** of which the camera main body **60** couples rotatably with the optical system installed part **61** and through the tubular portion, two

parts are electrically connected with wire.

Further, **94** shown in Fig. 38 is a cam pushing pin; **95** is a cam spring; and **96** is a image capturing unit; these are described later.

The above optical system installed part **61** is unnecessary to provide a lenses barrel and can be made with a depth fit to the lens diameter so as to be appropriate to a very thin type electronic camera.

Fig. 39 is a perspective illustration of the driving mechanism for zooming **90**.

This driving mechanism for zooming **90** has a configuration similar to the driving mechanism for zooming **20** or **50**. Only what is different in this driving mechanism for zooming is that the cam for zooming **25** is disposed at the left side of the photographic lens groups and the motor for zooming **26** is disposed in front, the motor for focusing is disposed in rear.

A thinner camera than a camera in which two motors are disposed as overlapped can be obtained in this way by disposing the motor for zooming **26** and the motor for focusing **33** separately at front side and rear side. Further, electro magnetic interference between two motors can be avoided.

As for a cam for zooming **25**, as shown in Fig. 40, a cam base body **251** is formed from two cylinder type base bodies **351**, **352**. More particularly, an inserting shaft portion **351a** of the cylinder type base body **351** is inserted into a cylinder type base body **352** and an eccentric pin **74** is inserted through a hole portion **352a** of the cylinder type base body **352** to fix to a pin hole of the inserting shaft portion **351a** so that these cylinder type base bodies **351, 352** are combined together.

That is, the distance between the one cam plane **40a** formed on the cylinder type base body **351** and the one cam plane **41a** formed on the cylinder type base body **352** is finely adjusted by rotating the eccentric pin **74** for adjusting an inserted depth of the inserting shaft portion **351a**.

In addition, as already stated above, the first and second cam groove **40, 41** are formed by the one cam planes **40a, 41a** and the other cam planes **40b, 41b** of the cam frame **252, 253**.

Meanwhile, a pin receiving umbo **252e** is projectingly formed toward the inner portion on the cam frame **252** of the cam for zooming **25** so as to slide in a long hole **351c** of the cylinder type base body 351. The cam frame **252, 253** and the cam base body **251** are pressed in one direction by pressing the pin receiving umbo **252e** with the cam pressing pin **94**.

As shown in Fig. 37, the cam pressing pin **94** is inserted through a hole **27c** of a front fixing frame **27** and its tip is contacted to the pin receiving umbo **252e**. Pressing force is given to the cam pressing pin **94** by a cam spring **95** provided in the above hole **27c**. The cam pressing pin **94** and the cam spring **95** are prevented to come off with a plate extended from the flash part **81**.

In the cam for zooming **25**, the cam frame **253** rotates together with the cylinder type base body **352** by fitting a protruded portion of a key provided in it to a key groove **352b**.
Also provided is the cam frame **252** with an interlocking gear **75** which is driven through a rate reducing device **44** with a motor.

The rate reducing device **44** of the driving mechanism for zooming **90** is, as shown in Fig. 41, comprises a front gear group and a rear gear group. The front gear group comprises a gear **44b** a large diameter gear portion of which is engaged with a pinion **44a** of the motor for zooming **26** and a gear **44c** which is engaged with a small diameter gear portion of the gear **44b**.
In addition, a gear **44c** is provided at the front end of a rotational axis rod **44d** through which the rear gear group is interlocked.

The rear gear group comprises a gear **44e** provided at the rear end of the rotational axis rod **44d**, a gear **44f** a large diameter gear portion of which engages the gear **44e**, and a gear **44g** a large diameter gear portion of which engages a small diameter gear portion of the gear **44f**. An interlocking gear **75** of the cam frame **253** engages the small diameter gear portion of the gear **44g**.

Since gear groups comprises the front gear group and the rear gear group, a place for the rate

reducing gear is divided into two, the rate reducing device **44** can be fit with the photographic lens diameter so as to be appropriate for making a thin optical system absorption part **61**.

To explain more particularly, in order to secure an enough rate reducing ratio for disposing a whole reducing gears in one place, a rate reducing gear group needs to be extendedly disposed in a direction of zooming of the mechanism for zooming, which leads to a long mechanism for zooming to prevent miniaturization.

Also in order to secure an enough rate reducing ratio without changing a length, the gear needs to be big in diameter so that a rate reducing device fit to a diameter of the lens can not be realized, which result in preventing miniaturization.

Fig. 11 is an exploded perspective view of an image capturing unit **96**. The image capturing unit 96 comprises a holder **354**, a mask **353**, a filter (LPF) **352**, a rubber **351**, a CCD **320**, a plate **355** and a circuit board **358**. More particularly, the image capturing unit **96** is configured in such a manner that the mask **353**, the filter **352**, the rubber **351** and the CCD are disposed between the holder **354** and the plate **355**, the holder **354** is fixed to the plate with a small screw **356** to form one unit, after that the CCD **320** is electrically connected to the circuit board **358**, and the circuit board **358** is fixed.

The image capturing unit **96** made in this way is fixed to the rear fixing frame **28** of the driving mechanism for zooming **90**, as shown in Fig.42 and Fig.43.

More particularly, the rear fixing frame **28** has a standard plane **28b** and a fixing prong **28c** and leaf springs **105**, **106** which hold the image capturing unit **96** are attached to the rear fixing frame **28**.

Therefore, when flange portions of the plate **355** are inserted between the standard plane **258b** and the leaf springs **105**, **106**, the one fixing prong **28c** plunges in a fixing hole **102a** of the plate **355** and the other fixing prong **28c** catches the a fixing groove **102b** of the plate **355** so that the image capturing unit **96** is fixed by the elastic holding force of the two leaf springs **105**, **106**.

Though Fig. 42, 43 shows a state in which the circuit board **358** is taken off, the image

capturing unit **96** is actually attached as shown in Fig. 44.

Though one embodiment of the present invention is explained above, the optical zoom mechanism of this embodiment can be executed on other optical instruments not limited to the camera. Further, this can also be executed a cam body comprising a cam base body **251** and one cam frame **252**(or **253**). In this case, a gear is provided on the cam base body **251** or cam frame **252** to engage a first rate reducing gear. As another embodiment, the first rate reducing gear can be caused to mesh with an inner gear **42** provided to the cam for zooming **25** shown in Fig. 30.

Further, a rate reducing device 44 provided to the interlocking system between the cam for zooming 25 of the driving mechanism for zooming of the photographic lens and the motor for zooming 26 has been explained. It can carry out similarly as a rate reducing device of a cam for zooming which zooms a zooming lens of a finder or a flash unit or a lead screw which zooms.

Further, in the above mentioned optical zoom mechanism, the zoom lens is driven by inserting a cam groove inserting member provided on the holding frame into a spiral cam groove of the cam body, the cam body comprises one cam body which forms one cam plane and another cam body which forms another cam plane, which is provided non-rotatably so as to be able to slide and which forms another cam plane confronting the one cam plane, and the cam body further comprises a forcing device which contact the cam groove inserting member to the cam plane by pressing one cam body and/or another cam body.

Further, in this embodiment, an optical zoom mechanism is proposed, which drives the zoom lens by inserting the cam groove inserting member provided on the holding frame into the spiral cam groove of the cam body wherein the cam body comprises a cam base body having a first spiral cam groove, a second spiral cam groove, a sliding portion having a smaller diameter at both ends of a cylinder, one cam plane of the first cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder, and one cam plane of the second cam groove which is provided at a stepped portion between another sliding portion and the middle portion of the cylinder; another cam plane confronting the one cam plane of the

first cam groove; a first cam frame provided non-rotatably so as to be able to slide on the one sliding portion; another cam plane confronting the one cam plane of the second cam groove; a second cam frame provided non-rotatably so as to be able to slide on the other sliding portion; and further a forcing device which contact a cam groove inserting member to the cam plane by pressing the first cam frame and the second cam frame, the cam groove inserting member inserted into two cam grooves which formed with the first cam frame, the second cam frame and the cam base body.

Further, in this embodiment, an optical zoom mechanism is proposed, which drives the zoom lens by inserting the cam groove inserting member provided on the holding frame into the spiral cam groove of the cam body wherein the cam body comprises a cam base body which is constructed by connecting one base body part having a first spiral cam groove, a second spiral cam groove, a sliding portion having a smaller diameter at one end of a cylinder, and one cam plane of the first cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder to another base body part having a sliding portion having a smaller diameter at one end of a cylinder, and one cam plane of the second cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder; another cam plane confronting the one cam plane of the first cam groove; a first cam frame provided non-rotatably so as to be able to slide on the one sliding portion; another cam plane confronting the one cam plane of the second cam groove; a second cam frame provided non-rotatably so as to be able to slide on the other sliding portion; and further a forcing device which contact a cam groove inserting member to the cam plane by pressing the first cam frame and the second cam frame, the cam groove inserting member inserted into two cam grooves which formed with the first cam frame, the second cam frame and the cam base body.

Further, in this embodiment, a camera having an optical zoom mechanism is proposed, the optical zoom mechanism comprising a zoom lens, a holding frame which holds the zoom lens, a rotational axis rod having gears at the both end thereof, a first group of rate reducing gears which engage the gear at one end of the rotational axis rod, a second group of rate reducing gears which engage the gear at another end of the rotational axis rod, a cam body driven by the first rate

reducing gears, and a motor which drives the second group of rate reducing gear, whereby zooming is performed by moving the holding frame with the cam body to focus a photographic image on the image capturing element.

Further, in this embodiment, a camera is proposed, wherein, in the optical zoom mechanism, the zoom lens is driven by inserting a cam groove inserting member provided on the holding frame into a spiral cam groove of the cam body, the cam body comprising one cam body which forms one cam plane and another cam body which forms another cam plane, which is provided non-rotatably so as to be able to slide and which forms another cam plane confronting the one cam plane, and the cam body further comprising a forcing device which contact the cam groove inserting member to the cam plane by pressing one cam body and/or another cam body.

Further, in this embodiment, a camera is proposed, wherein, in the optical zoom mechanism, the zoom lens is driven by inserting a cam groove inserting member provided on the holding frame into a spiral cam groove of the cam body, the cam body comprising a cam base body having a first spiral cam groove, a second spiral cam groove, a sliding portion having a smaller diameter at both ends of a cylinder, one cam plane of the first cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder, and one cam plane of the second cam groove which is provided at a stepped portion between another sliding portion and the middle portion of the cylinder; another cam plane confronting the one cam plane of the first cam groove; a first cam frame provided non-rotatably so as to be able to slide on the one sliding portion; another cam plane confronting the one cam plane of the second cam groove; a second cam frame provided non-rotatably so as to be able to slide on the other sliding portion; and further a forcing device which contact a cam groove inserting member to the cam plane by pressing the first cam frame and the second cam frame, the cam groove inserting member inserted into two cam grooves which formed with the first cam frame, the second cam frame and the cam base body.

Further, in this embodiment, a camera is proposed, wherein the cam body comprises a cam base body which is constructed by connecting one base body part having a first spiral cam groove, a second spiral cam groove, a sliding portion having a smaller diameter at one end of a cylinder,

and one cam plane of the first cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder to another base body part having a sliding portion having a smaller diameter at one end of a cylinder, and one cam plane of the second cam groove which is provided at a stepped portion between one sliding portion and the middle portion of the cylinder; another cam plane confronting the one cam plane of the first cam groove; a first cam frame provided non-rotatably so as to be able to slide on the one sliding portion; another cam plane confronting the one cam plane of the second cam groove; a second cam frame provided non-rotatably so as to be able to slide on the other sliding portion; and further a forcing device which contact a cam groove inserting member to the cam plane by pressing the first cam frame and the second cam frame, the cam groove inserting member inserted into two cam grooves which formed with the first cam frame, the second cam frame and the cam base body.

When the above mentioned optical zoom mechanism or the camera is activated with a motor, since the first rate reducing gear group is rotatively driven to communicate a rotational driving force to the rotational axis rod first of all, the second rate reducing gear group which interlocks with the rotational axis rod receives the rotational driving force. Therefore, a power mechanism is rotated by interlocking with the second rate reducing gear so as to zoom the optical system.

Regarding thus constructed optical zoom mechanism or camera, each gear construction of the first or second rate reducing gear does not become large because a rate reducing gear group of the first and second is divided into two gear groups. Therefore, two mounting spaces are necessary. However, each space can make small so that a thin or miniature type camera can bear. Further, since a lot of gears are dispersed to the first and second gear groups, the structure of the gears does not become complicated and is capable of variety of gear disposition.

As mentioned above, regarding the optical zoom mechanism or the camera of this embodiment, the first and second rate reducing gear groups can be mounted separately in narrow spaces since a lot of rate reducing gears are divided into the first and second rate reducing gear groups.

Further, since a gear structure is made as two gear groups of the first and second gear groups, the structure of the gears is capable of variety of gear disposition, which result in slimming or miniaturizing the camera.

Fourth Embodiment

A driving mechanism for zooming **10** shown in Fig. 45 is configured in such a manner that cam pins **11c**, **12c** caused to be pressed to first and second cam planes **17a**, **17b** by giving pressing force in a direction approaching each other with a spring force of a coil spring **18** to a cam pin **11c** of a first lens group **11** and a cam pin **12c** of a second lens group **12**.

Therefore, when the first lens group **11** and the second lens group **12** move along the optical axis, a distance between the first lens group **11** and the second lens group becomes large to increase a spring force of the coil spring **18** due to the cam form of a cam for zooming **25** so that contact pressure of the cam pin **11c**, **12c** to the cam plane increases.

When a distance between the first lens group **11** and the second lens group becomes small, on the contrary, contact pressure of the camp in **11c**, **12c** to the cam plane decreases because of decrease of a spring force of the coil spring **18**.

In other words, as rotational driving force of the cam for zooming **17** for moving the lenses varies depending on each position for zooming the first and second lens group **11**, **12**, contact pressure of cam pins **11c**, **12c** increases most at the zooming position where a distance between the first and second lens groups **11**, **12** is greatest to need the greatest rotational driving force.

Therefore, the conventional driving mechanism for zooming **10** needs a motor **19** capable of rotating smoothly the cam for zooming **17** even at the zooming position of the greatest contact pressure of the cam pins **11c**, **12c**. Accordingly, an expensive motor or a big motor is necessary as a motor **19**. Further, as a high loading current flows through the motor **19** depending on zooming position, it is not favorable in terms of electricity consumption.

On the other hand, since a driving mechanism for zooming **110** shown in Fig. 46 is configured in such a manner that the cam pins **11c**, **12c** is pressed to a cam plane by giving a tensile force of the coil spring **18** to the lens frame **11a** of the first lens group **11** and the lens frame **12a** of the second lens group **12**, there are such problems that the first and second lens groups become slanting or eccentric.

More particularly, since the first and second lens groups **11**, **12** move in compliance with the rotation of the first and second cam grooves **111a**, **111b** and their cam grooves form, the greater a distance between the first and second lens group **11**, **12** becomes, the greater a force of the coil spring **18** becomes.

Therefore, the greater a distance between the first and second lens groups becomes, the greater the lens frames **11a**, **12a** slant by a tensile force of the coil spring **18**. Also, the slant of the first and second lens group **11**, **12** causes the eccentricity of the lens.

The greater is the mechanical play of the axis holes of the bosses **11b**, **12b** to the guide shaft **13**, the greater becomes thus generated slanting and eccentricity of the first and second lens groups. Hence, it is preferable to diminish the mechanical play as possible. However, since a definite mechanical play needs to be set in order to slide smoothly the bosses **11b**, **12b**, the above mentioned slanting and eccentricity generate.

First and second cam grooves **111a**, **111b** of the above mentioned cam for zooming **111** are formed as cam grooves having an opening slant, as shown in Fig. 47 for example. Also taper is formed on the cam pins **11c**, **12c**.

Therefore, when a projecting direction of the cam pins **11c**, **12c** vary corresponding to the slant of the first and second lens groups **11**, **12**, contact points of the cam pin **11c**, **12c** to the cam plane shift so that fluctuation of a moving distance generates. That is, because a cam axis deviates, the normal position of the first and second lens groups shift so that a moving distance of the lens

groups **11**, **12** fluctuates depending on the zooming position, which leads to lowering of accuracy of zooming.

In view of the above mentioned situation, as an embodiment of the present invention, there are presented a cam apparatus having cam pins of an even pressing force to a cam plane so as to be able to diminish a rotational driving power of the cam at best, a cam apparatus that does not cause a moving object sliding on a guide shaft to generate slant, and a cam apparatus that does not cause a moving distance of a moving object to generate fluctuation. Further, a camera having said cam apparatus as a cam for zooming of an optical system is presented.

Now, referring to drawings, a fourth embodiment of the present invention of an electronic camera is explained as follows.

Fig. 27 is a perspective illustration showing a driving mechanism for zooming **20** of a photographic lens. Fig. 28 is a front elevational view of the above driving mechanism for zooming **20**.

In the drawings, **21** is a first lens group; **22** is a second lens group; the first and second lens groups are made similarly to the conventional ones shown in Fig. 45, 46. A guide shaft is pierced through a boss **21b** provided on a lens frame **21a** and through a boss **22b** provided on a lens frame **22a** so as to be able to slide. The guide shaft **23** holds the first and second lens groups **21**, **22**.

Holes (unshown) are provided at the positions of the lens frame **21a**, **22a** opposite to the bosses **21b**, **22b**. The guide shaft **24** is pierced through these holes so as to be able to slide whereby the first and second lens groups do not rotate.

Further, a cam pin (a cam groove inserting member) **21c** of the first lens group **21** formed projectingly on the boss **21b** and a cam pin (a cam groove inserting member) **22c** of the second lens group **22** formed projectingly on the boss **22b** are inserted into a cam groove of a cam for zooming **25**. The first and second lens groups are cam-driven along a direction of the optical axis

by rotating the cam for zooming **25** (see Fig. 29). Additionally, the cam for zooming **25** is driven by a motor for zooming **26**.

One ends of the guide shaft **23** and the guide shaft **24** are fixed to a front fixing frame **27** and another ends are fixed to a rear fixing frame **28**. The cam for zooming **25** is rotatably supported with a bearing portion **27a** of the front fixing frame **27** and a bearing portion **29a** of a supporting fixing frame **29** fixed to the rear fixing frame **28** (see Fig. 18)

Window holes **27b**, **28a** through which object image light passes are formed on the front fixing frame **27** and the rear fixing frame **28**. Further, a CCD (an solid image forming element) is mounted in right after the window of the rear fixing frame **28** (see Fig. **27**, **29**).

While, a third lens group **31** shown in Fig. **27** is a lens for focusing and is supported by piercing the guide shaft **23** to a boss **31a** provided on the lens frame **31a**. The third lens group **31** is screw-driven by a lead screw **34** rotatively driven with a motor for focusing **33** to advance and retreat along the optical axis.

Besides, referring to Fig. 27, **35** is a shutter unit fixed to the lens frame **22a**; **36** is a cover plate; **37** is a photo interrupter for zooming; **38** is a photo interrupter for focusing; and **39** is a spring for preventing a play of the third lens group **31**, the spring which presses the boss in one direction to absorb the play between the lead screw **34** and a nut **32**. The photo interrupter for zooming **37** detects an initial position for zooming and the photo interrupter for focusing detects an initial position for focusing.

In the above configured driving mechanism for zooming of the photographic lens, the first and second lens group **21**, **22** moves for zooming by driving rotatively the cam for zooming **25** with the motor for zooming **26** and the third lens group **31** moves for focusing by driving rotatively the lead screw **34** to screw-drive the nut screw **32**.

In addition, the third lens group **31** moves also at the time of zooming.

The cam **25** for zoom with which the above-mentioned driving mechanism for zooming **20** is equipped as a cam apparatus on the other hand is explained with reference to Fig. 29, Fig. 30,

and Fig. 31.

Fig. 29 is the same perspective illustration of a cam for zooming as Fig. 27 when the third lens group, the motor for focusing **33**, the shutter unit **35**, the cover plate **36** and so on are removed for showing. Fig. 30 is a perspective illustration of a cam for zooming **25**. Fig. 31 is an exploded perspective illustration of a cam for zooming.

As shown in the drawing, the cam **25** for zooming is a cylindrical cam having a first cam groove **40** and a second cam groove **41** and comprises a cylindrical cam base body **251**, cylindrical cam frames **252**, **253** which fit the both sides of the cam base body **251** so as to be able to slide, and a tensile coil spring **254** pressing the cam frames **252**, **253** in a direction for approaching each other.

A cam base body **251** has a sliding portions **251b**, **251c** having a smaller portion at the both sides of the middle portion **251a**. One cam plane **40a** is formed for forming a first cam groove **40** at a stepped portion between the middle portion **251a** and the sliding portion **251b**. One cam plane **41a** is formed for forming a first cam groove **41** at a stepped portion between the middle portion **251a** and the sliding portion **251c**. The cam base body **251** has long holes **251d**, **251e** along an axial direction from the both ends, into which protruded portions **252a**, **253a** are fit so as to be able to slide, whereby the cam frames **252**, **253** are rotated together with the cam base body **251**. A hole portion **251f** formed at the ends of sliding portion **251b**, **251c** is to attach a coil spring **254**. Stepped portions **251g**, **251h** are to restrict movement of a cam frame **252**, **253**.

Meanwhile, a cam frame **252** has another cam plane **40b** for forming a first cam groove **40** at one end circumference portion and further has a pointing inner flange **252b**. The cam frame **252** has a spring hooking portion **252c** projected from the protruded portion **252a** in the cylinder.

A cam frame **253** has another cam plane **41b** for forming a first cam groove **41** at one end circumference portion and further has a pointing inner flange **253b**. The cam frame **253** has a spring hooking portion **253c** projected from the protruded portion **253a** in the cylinder.

With regard to the cam base body **251**, the cam frames **252**, and **253**, after the cam frame **252** is fit to the sliding portion **251b** of the cam base body **251** and the cam frame **253** is fit to the sliding portion **251c**, one end of coil spring **254** is hooked to the spring hooking portion **252c** of the cam frame **252** and another end is hooked to the spring hooking portion **253c** of the cam frame **253**.

Then the coil spring **254** presses the cam frame **252** and **253** in a direction of aproaching each other so that the flange portion **252b** advances until it strikes the stteped portion **251g** as the cam frame **252** slides the sliding portion **251b**. With this state, the first cam groove is formed by the one cam plane **40a** and the other cam plane **40b**.

Likewise, the cam frame **253** slides the sliding portion **251c** and the flange portion **253b** advances until it strikes the stteped portion **251h** so that the second cam groove is formed by the one cam plane **41a** and the other cam plane **41b** with this state.

Thus formed cam grooves **40**, **41** become spring shaped cam grooves matched with movement of the first and second lens groups **21**, **22** necessary to zooming.

As shown in Fig. 29, in the cam for zooming **25** configured as described above, the cam pin **21c** of the first lens group **21** is inserted into the cam groove **40** and the cam pin **22c** of the second lens group **22** is inserted into the cam groove **41**. By the insertion of the cam pins **21c**, **22c** like this way, the flange poriton **252b** of the cam frame **252** retreats a little from the stepped portion **251g** and likiwise, the flange poriton **253b** of the cam frame **253** retreats a little from the stepped portion **251h**.

Therefore, since the cam pin **21c** is pressed to the cam plane **40b** of the cam frame **252** and the cam pin **22c** is pressed to the cam plane **41b** of the cam frame **253**, the cam pins **21c**, **22c** contact to the cam plane with a definite contact pressure over the whole region of the cam grooves **40**, **41**. A contact pressure of the cam pins **21c**, **22c** to the cam plane can be determined by a tensile force of the coil spring **254**. A most appropriate contact pressure of the cam pins **21c**, **22c** is available when the coil spring **254** having an appropriate tensile force is chosen.

Thus, the cam for zooming **25** can be rotated with a definite motor driving force and the first and the second lens groups **21**, **22** can be smoothly driven for moving. As a result, the cam for zooming **25** becomes a cam apparatus having a light load of small fluctuation so that a small and power-saving motor can be used as a motor for zooming **26**.

Fig. 18 is a cross sectional drawing showing a cross section of the cam for zooming **25** and its driving system by cutting by the A-A line of Fig. 28.

As shown in the drawing, a cam for zooming **25** of this second embodiment is explained. An inner gear **42** is provided at a rear end side of the cam for zooming **25**. A protruded portion 42a of the inner gear is inserted into an inner hole of the cam base body **251**. A key **42b** provided at a circumferential portion of the protruded portion **42a** fits in a key groove **251i** formed in an inner hole portion of the cam base body **251**.

Accordingly, the cam for zooming **25** rotates together with the inner gear **42**.

The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**.

The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

In the driving mechanism for zooming 20 exerted as above, the cam pins **21c**, **22c** exert a definite contact pressure over the whole region of the first and second cam groove **40**, **41**; the width in a lateral direction of the camera (width in a direction of left and right in Fig. 28) can be shortened in addition; and further the first and second lens groups **21**, **22** for zooming and the third lens group **31** are movably supported with the same guide shafts **23** so that the lens groups are difficult to fall or become eccentric.

Fig. 19 shows a driving mechanism for zooming **50** of the second embodiment.

The driving mechanism for zooming 50 is characterized in that the other cam planes **40b**, **41b** formed on the cam frames **252**, **253** are slanted at an predetermined angle, though, other features

are the same as the driving mechanism for zooming **20** shown in Fig. 27-28.

Fig. 19 corresponds to a cross sectional view by the b-b line in Fig. 28.

Fig. 20 is a Fig. 20 is a partially enlarged cross sectional drawing showing a configured portion formed by the first and second cam grooves **40, 41** together with the cam pins **21c, 22c**. As seen in the drawing, the other cam planes of the first and second cam frames **252, 253** are formed as slanting cam planes having a rising gradient to the periphery of the frame.

The cam pins **21c, 22c** receive a pushing force in a direction of **F1** shown in the drawing because the other cam planes **40b, 41b** are formed as slanting planes. That is, as a spring force in a direction of F2 shown in the drawing is exerted to the first and second cam fames **252, 253** with the coil spring **254**, the first and second cam fames receive a pressing force **F1** in a direction orthogonal to the rotational axis of the cam groove in addition to the contact pressure of the cam pins **21c, 22c** pressed by a slanting plane of the other cam planes **40b, 41b** to the one cam plane **40a, 41a**.

The above mentioned pressing force **F1** which acts on the cam pins affects in such a manner that hole plane portions of supporting holes **21d, 22d** of the bosses **21b, 22b** contacts the guide shaft **23** so as to absorb mechanical play between the supporting shaft holes **21d, 22d** and the guide shaft **23**.

In the cam for zooming **25** as configured above, the cam pins **21c, 22c** contact a whole region of the first and second cam grooves **40, 41** with a definite contact pressure and are driven to move in a direction of the rotational axis of the cam groove according to rotation of the cam for zooming **25** so that the first and second lens groups **21, 22** move along the guide shaft **23**.

Further, since the bosses **21b, 22b** slide the guide shaft **23** without mechanical play as mentioned above, the second lens groups **21, 22** do not become slanting or eccentric. As a result, the driving mechanism for zooming has a cam for zooming **25** (cam apparatus) capable of upgrading zooming accuracy.

Fig. 21 (A), (B), (C) are cross sectional drawings showing other embodiments similar to Fig. 20 wherein a slanted position of the cam plane of the first and second cam grooves **40**, **41**. Fig. 21 (A) is a cross sectional drawing showing one cam planes **40a**, **41a** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (B) is a cross sectional drawing showing one cam planes **40a**, **41a** and other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (C) is a cross sectional drawing showing other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41** and cam pins **21c**, **22c**, which are formed slantingly.

Since a pressing force **F1** acts to the cam pins **21c**, **22c** in the event of the above configuration, play between the bosses **21b**, **22b** and the guide shaft **23** can be absorbed similarly to the embodiment shown in Fig. 20 so that slant or eccentricity of the first and second lens groups **21**, **22** ca be prevented.

Further, when the both cam planes are formed slantingly as shown in Fig. 21 (B), smoother zooming action can be realized compared to the one with one slanted cam plane.

Also in the embodiment shown in Fig. 20, Fig. 21 (A), (B), the contact portion of the cam pins **21c**, **22c**, which contact the cam plane may be formed slantingly.

Fig. 22 shows another embodiment of a driving mechanism using a cam for zooming **25** of this third embodiment. Fig. 22 shows a driving mechanism in which a coil spring **45** is provided at a bearing portion **27a** of a front fixing frame **27** in order to absorb a bearing play of the cam for zooming **25**. The coil spring **45** enhances an accuracy of the moving position of the first and second lens groups **21**, **22** preventing from movement of the cam for zooming **25** in a direction of the rotational axis by pressing the cam for zooming **25** in one direction.

Fig. 23 shows an embodiment wherein a bearing play of the cam for zooming **25** and first and second cam frames **252**, **253** is pressed with a coil spring 46 by providing a coil spring **46** at a bearing part **27a** of a front fixing frame **27**.

This embodiment is configured in such a manner that a cam base body **251** is pressed through

a cam pin **21c** by pressing a first cam frame **252** and a second cam frame **253** is pressed in one direction through a cam pin **22c**. With this configuration, a coil spring **254** hooked between the cam frames **252** and **253** becomes unnecessary.

Fig. 32-34 show a zooming mechanism similar to the zooming mechanism **20** or **50** described above for a lens barrel less electronic camera (digital camera) having no lens barrel as an example.

Fig. 32 is a camera plan view. Fig. 33 is a camera front elevational view. Fig. 34 is a camera rear elevation view of an electronic camera shown in Fig. 32.

As shown in the drawings, the electronic camera has a form having a big longitudinal and transversal width and a small depth in a front view so that the camera is thin.

The electronic camera has two separate box-like bodies as a camera main body 60 provided with a controller, a memory card, a computing part, a memory card slot and others and as an optical system installed part 61 provided with a photographic lens and others.

And the camera main body 60 is rotatably within reasonable bounds coupled with the optical system installed part 61 by a coupling part 62.

As shown in the drawing, on the upper plane of the camera main body **60**, a shutter button and a power switch are provided; on the back plane of the camera main body **60**, a liquid crystal monitor **65**, selection and decision button **66**, a zoom button **67**, mode selecting button **68** and others are provided; further, various circuit boards including a CPU, a battery which supplies electric power, a memory card slot are installed in the camera main body **60**(unshown).

Further, a photographic lens window **69** and a flash window of a flash unit **70** are provided on the upper plane of the optical system installed part **61**,and a zooming mechanism part **20, 50, 90** and a flash unit **80** stated later are installed by shielding light in the optical system installed part **61**.

Thus, while disposing a display unit, an operation unit, a battery, a memory card slot, and a

circuit board in the camera main body **60**, thin shape of the whole camera is realized by integrating an optical mechanism and the flash unit **80** in the optical system installed part **61**.

Since the above mentioned electronic camera is a very thin type of camera, it is convenient to carry.

On the other hand, when taking a photograph, as shown in Fig. 35 for example, the optical system installed part **61** is rotated so that the photographic lens window **69** points at the front.

Since the camera main body **60** is grasped by hand and the shutter can be released in this state, the camera shake scarcely occurs with this camera.

Moreover, as the optical system installed part **61** can be rotated to an opposite side to that shown in Fig. 35, it can be pointed at the same direction as the liquid crystal monitor **65** for photographing.

Fig. 36 is a perspective illustration of an optical system installed part **61** when a rear case is removed. Fig. 37 is a transverse sectional view of the above optical system installed part. Fig. 38 is an exploded perspective illustration of the above optical system installed part **61**.

As seen in these drawings, the optical system installed part **61** has a flash unit **80** and a driving mechanism for zooming (a optical system unit) **90** of photographic lenses mounted in a box like front case (camera case) **71** so as to be a lens barrel less type having no lens barrel. The above units and others are installed by shielding light.

Therefore, the optical system installed part **61** is restricted to a thickness defined by a height of the optical unit which formed thin so that a thin type of camera is realized.

The flash unit **80** resides in the innermost portion of the flash part **81** and the front case **71** and has a main condenser **82** disposed adjacently at the rear of the optical system unit and a circuit board **83** at the side of the optical system unit in the front case **71**.

The driving mechanism for zooming **90** is disposed in the frond case **71** by screwing with small screws **91**. A photographing image light enters in an image capturing optical system consisting of the first, second and third lens groups through the photographic lens window **69**.

In addition, the cover 92 which prevents invasion of solder waste, dust, and others is provided on the driving mechanism for zooming **90**.

As mentioned above, the rear case **72** is fixed with a screw to the front case **71** to which the flash unit **80** and driving mechanism for zooming **90** are mounted.

More particularly, as shown in Fig. 38, the rear case **72** is fixed to the front case **71** with the small screw **93** which is inserted into the one side of the rear case **72** from the front case **71**. The other side of the rear case **72** is screwed with the one side of a tongue flange **62a** of the coupling part **62**.

That is, the one side of the tongue flange **62** of the coupling part **62** is fixed with a small screw **73** to the front case **71** and rear case **72** so as to unite together.

In addition, the other side of the tongue flange **62b** of the coupling part **62** is screwed to the case of the camera main body **60**, with a tubular portion **62c** of which the camera main body **60** couples rotatably with the optical system installed part **61** and through the tubular portion, two parts are electrically connected with wire.

Further, **94** shown in Fig. 38 is a cam pushing pin; **95** is a cam spring; and **96** is a image capturing unit; these are described later.

The above optical system installed part **61** is unnecessary to provide a lenses barrel and can be made with a depth fit to the lens diameter so as to be appropriate to a very thin type electronic camera.

Fig. 39 is a perspective illustration of the driving mechanism for zooming **90**.

This driving mechanism for zooming **90** has a configuration similar to the driving mechanism for zooming **20** or **50**. Only what is different in this driving mechanism for zooming is that the cam for zooming **25** is disposed at the left side of the photographic lens groups and the motor for zooming **26** is disposed in front, the motor for focusing is disposed in rear.

A thinner camera than a camera in which two motors are disposed as overlapped can be obtained in this way by disposing the motor for zooming **26** and the motor for focusing **33**

separately at front side and rear side. Further, electro magnetic interference between two motors can be avoided.

As for a cam for zooming **25**, as shown in Fig. 40, a cam base body **251** is formed from two cylinder type base bodies **351**, **352**. More particularly, an inserting shaft portion **351a** of the cylinder type base body **351** is inserted into a cylinder type base body **352** and an eccentric pin **74** is inserted through a hole portion **352a** of the cylinder type base body **352** to fix to a pin hole of the inserting shaft portion **351a** so that these cylinder type base bodies **351, 352** are combined together.

That is, the distance between the one cam plane **40a** formed on the cylinder type base body **351** and the one cam plane **41a** formed on the cylinder type base body **352** is finely adjusted by rotating the eccentric pin **74** for adjusting an inserted depth of the inserting shaft portion **351a**.

In addition, as already stated above, the first and second cam groove **40**, **41** are formed by the one cam planes **40a, 41a** and the other cam planes **40b, 41b** of the cam frame **252, 253**.

Meanwhile, a pin receiving umbo **252e** is projectingly formed toward the inner portion on the cam frame **252** of the cam for zooming **25** so as to slide in a long hole **351c** of the cylinder type base body 351. The cam frame **252, 253** and the cam base body **251** are pressed in one direction by pressing the pin receiving umbo **252e** with the cam pressing pin **94**.

As shown in Fig. 37, the cam pressing pin **94** is inserted through a hole **27c** of a front fixing frame **27** and its tip is contacted to the pin receiving umbo **252e**. Pressing force is given to the cam pressing pin **94** by a cam spring **95** provided in the above hole **27c**. The cam pressing pin **94** and the cam spring **95** are prevented to come off with a plate extended from the flash part **81**.

In the cam for zooming **25**, the cam frame **253** rotates together with the cylinder type base body **352** by fitting a protruded portion of a key provided in it to a key groove **352b**.

Also provided is the cam frame **252** with an interlocking gear **75** which is driven through a rate reducing device **44** with a motor.

The rate reducing device **44** of the driving mechanism for zooming **90** is, as shown in Fig. 41, comprises a front gear group and a rear gear group. The front gear group comprises a gear **44b** a large diameter gear portion of which is engaged with a pinion **44a** of the motor for zooming **26** and a gear **44c** which is engaged with a small diameter gear portion of the gear **44b**.
In addition, a gear **44c** is provided at the front end of a rotational axis rod **44d** through which the rear gear group is interlocked.

The rear gear group comprises a gear **44e** provided at the rear end of the rotational axis rod **44d**, a gear **44f** a large diameter gear portion of which engages the gear **44e**, and a gear **44g** a large diameter gear portion of which engages a small diameter gear portion of the gear **44f**. An interlocking gear **75** of the cam frame **253** engages the small diameter gear portion of the gear **44g**.

Since gear groups comprises the front gear group and the rear gear group, a place for the rate reducing gear is divided into two, the rate reducing device **44** can be fit with the photographic lens diameter so as to be appropriate for making a thin optical system absorption part **61**.

To explain more particularly, in order to secure an enough rate reducing ratio for disposing a whole reducing gears in one place, a rate reducing gear group needs to be extendedly disposed in a direction of zooming of the mechanism for zooming, which leads to a long mechanism for zooming to prevent miniaturization.

Also in order to secure an enough rate reducing ratio without changing a length, the gear needs to be big in diameter so that a rate reducing device fit to a diameter of the lens can not be realized, which result in preventing miniaturization.

Fig. 11 is an exploded perspective view of an image capturing unit **96**. The image capturing unit 96 comprises a holder **354**, a mask **353**, a filter (LPF) **352**, a rubber **351**, a CCD **320**, a plate **355** and a circuit board **358**. More particularly, the image capturing unit **96** is configured in such a manner that the mask **353**, the filter **352**, the rubber **351** and the CCD are disposed between the holder **354** and the plate **355**, the holder **354** is fixed to the plate with a small screw **356** to form

one unit, after that the CCD **320** is electrically connected to the circuit board **358**, and the circuit board **358** is fixed.

The image capturing unit **96** made in this way is fixed to the rear fixing frame **28** of the driving mechanism for zooming **90**.

More particularly, the rear fixing frame **28** has a standard plane **28b** and a fixing prong **28c** and leaf springs **105**, **106** which hold the image capturing unit **96** are attached to the rear fixing frame **28**.

Therefore, when flange portions of the plate **355** are inserted between the standard plane **258b** and the leaf springs **105**, **106**, the one fixing prong **28c** plunges in a fixing hole **102a** of the plate **355** and the other fixing prong **28c** catches a fixing groove **102b** of the plate **355** so that the image capturing unit **96** is fixed by the elastic holding force of the two leaf springs **105**, **106**.

Though Fig. 42, 43 shows a state in which the circuit board **358** is taken off, the image capturing unit **96** is actually attached as shown in Fig. 44.

As described in the above embodiment, according to the present invention, in the cam apparatus, the cam groove inserting member receives a pressing force in a direction orthogonal to the rotational axis in addition to a cam driving force in a direction of the rotational axis of the cam groove by spring force of the spring member given to the cam frame because the slanting portion is provided on the cam plane.

Therefore, since a mechanical play between the moving object and the guide shaft is absorbed by the above mentioned pressing force which acts to the cam groove inserting member, the moving object slides on the guide shaft without any mechanical play.

Further in this embodiment, as the above mentioned cam apparatus is provided to a camera as a cam for zooming, the cam for zooming can be of even and light load. As a result, a camera having a small and low cost driving source for the cam for zooming can be realized.

Further, regarding the cam for zooming having the slanting portion on the cam plane, as a mechanical play between the bearing portion of the zoom lens and the guide shaft is absorbed, slant or eccentricity of the lens scarcely generates so that a camera having a high accuracy of zooming is obtained.

Particularly, regarding the cam for zooming of this embodiment, as a distance between the first cam groove and the second cam groove can be finely adjusted, such a camera is obtained that an error of back focus caused by fluctuation due to parts or assembling can be adjusted.

An embodiment provided with the cam apparatus of this embodiment as a cam for zooming of the driving mechanism for zooming of the photographic lens was explained. The cam apparatus of this embodiment can be used as a cam apparatus which zooms a zoom lens of a view finder or a flash unit.

The cam apparatus of this embodiment is not limitted to a camera but can be performed as a cam apparatus provided to other apparatuses. In addition, the cam apparatus can comprise a cam base body **251** and one cam frame **252** (or **253**). In this case, a spring force in a contrary direction shall be given to the cam base body **251** and the cam frame **252**, or a spring force pressing in one direction the cam base body **251** together with the cam frame **252** shall be given.

According to the cam apparatus of this embodiment, since a cam plane of one cam body and a cam plane of another cam body forms a cam groove and a cam groove inserting member inserted into the cam groove contacts the cam plane by a forcing device pressing the cam body, the cam groove inserting member contacts the cam plane with an even contact pressure over all region of the cam groove.

Since a contact pressure of the cam groove inserting member can be determined by a spring force of the forcing device which presses the cam body, the cam groove inserting member can be contact to the cam plane with the most appropriate contact pressure.

Thus, besides a moving object moves smoothly, it is advantageous in terms of miniaturization and power saving of driving source such as a motor which rotates the cam body.

This embodiment is a cam apparatus wherein two cam grooves are formed by one cam plane of the first and second cam grooves formed on the cam body and by the other cam plane formed on the first and second cam frames and the cam groove inserting member inserted into each cam groove contacts the cam plane by a spring force of the forcing device which presses the first and second cam frame.

Therefore, each cam groove inserting member contacts the cam plane with even contact pressure over all region of the cam groove. As a result, a driving force by the two cam grooves moves each moving object smoothly, which leads to advantage in terms of miniaturization and power saving of driving source of the cam apparatus.

According to this embodiment, in a cam apparatus having first and second spiral cam grooves for moving an object with a cam driving force which is generated by cam-driving a cam groove inserting member inserted in each cam groove, there is proposed a cam apparatus provided with one base body part having a stepped portion between a sliding portion and a middle portion of a cylinder as one cam plane of a first cam groove, the sliding portion being formed at one end of the cylinder as a smaller diameter form and another base body part having a stepped portion between a sliding portion and a middle portion of a cylinder as one cam plane of a second cam groove, the sliding portion being formed at one end of the cylinder as a smaller diameter form, comprising a cam base body formed by connecting the one base body part to the other base body part, a first cam frame forming another cam plane confronting one cam plane of the first cam groove and provided non-rotatably at the sliding portion of the one base body part so as to be able to slide, a second cam frame forming another cam plane confronting one cam plane of the second cam groove and provided non-rotatably at the sliding portion of the other base body part so as to be able to slide, and a forcing device, which contacts each cam groove inserting member inserted into the two cam grooves formed by the first and second cam frames and the cam base

body to the cam plane.

According to this embodiment, a distance between the one cam planes of the first and second cam grooves can be adjusted. That is, the cam groove inserting member inserted into the first and second cam groove is moved to adjust in a rotational axis direction of the cam groove by adjusting the connecting portion of the cam base body so that an error of focus back caused by fluctuation due to parts or assembling can be adjusted.

According to this embodiment, in the aforementioned cam apparatus, a cam apparatus provided with an adjusting mechanism, which adjusts a distance between one cam planes of the first and second cam grooves is proposed.

According to this embodiment, in any one of the above cam apparatuses, a cam apparatus provided with a slanting portion on the cam plane of at least one cam plane of one cam plane and another cam lane is proposed.

According to this embodiment, since the slanting portion is provided on the cam plane on which the cam groove inserting member contacts, the cam groove inserting member receives a cam driving force in a direction of the rotational axis of the cam groove together with a pressing force in a direction orthogonal to the rotational axis.

More specifically, since the cam groove inserting member receives the above mentioned pressing force, in case a cam apparatus is made in such a manner that a moving object slides the guide shaft, the moving object contacts the guide shaft and a mechanical play between the moving object and the guide shaft is absorbed so that clatter movement of the moving object disappears.

According to this embodiment, a cam apparatus is proposed wherein a slanting portion provided on the at least one cam plane of the one cam plane and the other cam plane has a slanting plane which gives a cam driving force in a rotational axis direction of the cam groove

and a pressing force in a direction orthogonal to the rotational axis direction in the above mentioned cam apparatus.

Further, according to this embodiment, a cam apparatus is proposed wherein a forcing device for fastening to tighten one end of the forcing device to the first cam frame and another end to the second cam frame and a forcing device for pressing the first and the second cam frame to the cam base body along one direction in any one of the above mentioned cam apparatus.

Thus, the first and second cam frames can be pressed with one forcing device.

Further, according to this embodiment, a cam apparatus is proposed wherein a forcing device pressing the first and second cam frame and the cam base body in one direction is provided in any one of the above mentioned cam apparatus.

According to this embodiment, since the cam groove inserting member caused to contact the cam plane by the cam base body and whole of the first and second cam frame being pressed by the forcing device, and the whole cam apparatus is pressed in one direction, a mechanical play of the rotational axis portion of the cam apparatus is absorbed.

Further, according to this embodiment, a cam apparatus is proposed wherein a forcing device for fastening to tighten one end of the forcing device to the first cam frame and another end to the second cam frame and a forcing device for pressing the first and the second cam frame to the cam base body along one direction in any one of the above invention of a cam apparatus.

The apparatus of this invention has a structure of the previous invention plus a forcing device.

Further, according to this embodiment, there is proposed a camera comprising a zoom lens, a holding frame which holds the zoom lens, a cam groove inserting member provided on the holding frame, a cam apparatus which drives the zoom lens by inserting the cam groove inserting member into a spiral cam groove, a motor which supplies the cam apparatus a driving force, the cam apparatus further comprising one cam body which forms one cam plane of the cam groove, another cam body which is provided non-rotatably on the cam body so as to slide

and forms another cam plane confronting the one cam plane, and forcing device contacting the cam groove inserting member to the cam plane by pressing the one cam body and/or the other com body wherein optical zooming is performed by the cam apparatus.

Further, according to this embodiment, there is proposed a camera comprising a zoom lens, a holding frame which holds the zoom lens, a cam groove inserting member provided on the holding frame, a cam apparatus which drives the zoom lens by inserting the cam groove inserting member into a spiral cam groove, a motor which supplies the cam apparatus a driving force, the cam apparatus further comprising, a cam body having a first spiral cam groove, a second spiral cam groove, a sliding portion with a smaller diameter provided at the both ends of a cylinder, one cam plane of the first cam groove provided on a stepped portion between the one sliding portion and a middle portion of the cylinder, one cam plane of the second cam groove provided on a stepped portion between the other sliding portion and a middle portion of the cylinder, another cam plane formed by confronting the one cam plane of the first cam groove, a first cam frame provided non-rotatably on the one sliding portion so as to be able to slide, another cam plane formed by confronting the one cam plane of the second cam groove, a second cam frame provided non-rotatably on the other sliding portion so as to be able to slide, and a forcing device contacting the cam groove inserting member inserted into the two cam grooves formed by the first cam frame, the second cam frame and the cam base body on the cam plane, wherein optical zooming is performed by the cam apparatus.

Thus, as the cam pin presses the cam plane over whole region of the cam groove with even pressure, rotational driving force is approximately even regardless of the zooming position of the lens.

Therefore, a motor for driving a cam for zooming does not become large, which is appropriate for producing a low cost and miniaturized camera.

Further, according to this embodiment, there is proposed a camera comprising a zoom lens, a holding frame which holds the zoom lens, a cam groove inserting member provided on the holding frame, a cam apparatus which drives the zoom lens by inserting the cam groove

inserting member into a spiral cam groove, a motor which supplies the cam apparatus a driving force, the cam apparatus further comprising, one base body part having a first spiral cam groove, a second spiral cam groove, a sliding portion with smaller diameter provided at one end of a cylinder, and one cam plane of the first cam groove at a stepped portion provided between a sliding portion and a middle portion of the cylinder, another base body part having a sliding portion with smaller diameter provided at one end of the cylinder, and one cam plane of the second cam groove at a stepped portion provided between a sliding portion and the middle portion of the cylinder, a cam base body formed by connecting the one base body part and the other base body part, another cam plane formed by confronting the one cam plane of the first cam groove, a first cam frame provided non-rotatably on the one sliding portion so as to be able to slide, another cam plane formed by confronting the one cam plane of the second cam groove, a second cam frame provided non-rotatably on the other sliding potion so as to be able to slide, a forcing member, pressing the first cam frame and the second cam frame and contacting the cam groove inserting member inserted into two cam grooves formed by the first cam frame, the second cam frame and the cam base body on the cam plane wherein optical zooming is performed by the cam apparatus.

With regard to the camera that is made in this way, a distance between the first cam groove and the second cam groove can be adjusted so that an error of back focus caused by fluctuation due to parts or assembling can be adjusted.

According to this embodiment as described above, a cam apparatus or a camera wherein contact pressure of the cam groove inserting member can be made even over whole region of the spiral cam groove and cam driving force can be make small as a most appropriate contact pressure of the cam groove inserting member is obtained.

Fifth Embodiment

A conventional camera in which a lens barrel advances and retreats becomes difficult to configure the lens barrel as a camera form becomes smaller.

Particularly when camera form is made thin, there is a limit to designing a thin camera owing to a diameter of the lens barrel.

In view of the above situation, an object of this embodiment is also to make a camera having a zooming function as thin as possible.

With reference to accompanying drawings, a fifth embodiment according to the present invention when executed in an electronic camera is described as follows.

Fig. 27 is a perspective illustration showing a driving mechanism for zooming **20** of a photographic lens. Fig. 28 is a front elevational view of the above driving mechanism for zooming **20**.

In the drawings, **21** is a first lens group, **22** is a second lens group. The first and second lens groups are supported by a guide shaft **23** which is pierced so as to be able to slide to a boss **21b** provided on a lens frame **21a** and boss **22b** provided on a lens frame **22a**.

Holes are provided at the opposite position to the bosses **21b**, **22b** on the lens frames **21a**, **22a** and a guide shaft **24** is pierced to these holes so as to be able to slide to prevent rotation of the lens groups **21**, **22**.

Further, a cam pin (a cam groove inserting member) **21c** of the first lens group **21** formed projectingly on the above boss **21b** and a cam pin (a cam groove inserting member) **22c** of the second lens group **22** formed projectingly on the boss **22b** are inserted into the cam groove of the cam for zooming **25** so that the first and second lens groups are cam-driven along the optical axis according to rotation of the cam for zooming **25**(see Fig. 29). The cam for zooming **25** is rotatively driven by a motor for zooming **26**

One end of the guide shaft **23**, **24** is fixed to a front fixing frame **27** and another end is fixed to a

rear fixing frame **28**. The cam for zooming **25** is rotatably supported by a bearing portion **27a** of the front fixing frame **27** and a bearing portion **29a** (see Fig. 18) of a supporting fixing frame **29** fixed to the rear fixing frame **28**.

Window holes **27b**, **28a** through which object image light passes are formed on the front fixing frame **27** and the rear fixing frame **28**. Further, a CCD (an solid image forming element) is mounted in right after the window of the rear fixing frame **28** (see Fig. **27**, **29**).

While, a third lens group 31 shown in Fig. **27** is a lens for focusing and is supported by piercing the guide shaft **23** to a boss **31a** provided on the lens frame **31a**. The third lens group **31** is screw-driven by a lead screw **34** rotatively driven with a motor for focusing **33** to advance and retreat along the optical axis.

Besides, referring to Fig. 27, **35** is a shutter unit fixed to the lens frame **22a**; **36** is a cover plate; **37** is a photo interrupter for zooming; **38** is a photo interrupter for focusing; and **39** is a spring for preventing a play of the third lens group **31**, the spring which presses the boss in one direction to absorb the play between the lead screw **34** and a nut **32**. The photo interrupter for zooming **37** detects an initial position for zooming and the photo interrupter for focusing detects an initial position for focusing.

In the above configured driving mechanism for zooming of the photographic lens, the first and second lens group **21**, **22** moves for zooming by driving rotatively the cam for zooming **25** with the motor for zooming **26** and the third lens group **31** moves for focusing by driving rotatively the lead screw **34** to screw-drive the nut screw **32**.

In addition, the third lens group **31** moves also at the time of zooming.

The cam **25** for zoom with which the above mentioned driving mechanism for zooming **20** is equipped as a cam apparatus on the other hand is explained with reference to Fig. 29, Fig. 30, and Fig. 31.

Fig. 31 is the same perspective illustration of a cam for zooming as Fig. 27 when the third lens group, the motor for focusing **33**, the shutter unit **35**, the cover plate **36** and so on are removed

for showing. Fig. 30 is a perspective illustration of a cam for zooming **25**. Fig. 31 is an exploded perspective illustration of a cam for zooming.

As shown in the drawing, the cam **25** for zooming is a cylindrical cam having a first cam groove **40** and a second cam groove **41** and comprises a cylindrical cam base body **251**, cylindrical cam frames **252**, **253** which fit the both sides of the cam base body **251** so as to be able to slide, and a tensile coil spring **254** pressing the cam frames **252**, **253** in a direction for approaching each other.

A cam base body **251** has a sliding portions **251b**, **251c** having a smaller portion at the both sides of the middle portion **251a**. One cam plane **40a** is formed for forming a first cam groove **40** at a stepped portion between the middle portion **251a** and the sliding portion **251b**. One cam plane **41a** is formed for forming a first cam groove **41** at a stepped portion between the middle portion **251a** and the sliding portion **251c**.

The cam base body **251** has long holes **251d**, **251e** along an axial direction from the both ends, into which protruded portions **252a**, **253a** are fit so as to be able to slide, whereby the cam frames **252**, **253** are rotated together with the cam base body **251**. A hole portion **251f** formed at the ends of sliding portion **251b**, **251c** is to attach a coil spring **254**. Stepped portions **251g**, **251h** are to restrict movement of a cam frame **252**, **253**.

Meanwhile, a cam frame **252** has another cam plane **40b** for forming a first cam groove **40** at one end circumference portion and further has a pointing inner flange **252b**. The cam frame **252** has a spring hooking portion **252c** projected from the protruded portion **252a** in the cylinder.

A cam frame **253** has another cam plane **41b** for forming a first cam groove **41** at one end circumference portion and further has a pointing inner flange **253b**. The cam frame **253** has a spring hooking portion **253c** projected from the protruded portion **253a** in the cylinder.

With regard to the cam base body **251**, the cam frames **252**, and **253**, after the cam frame **252** is fit to the sliding portion **251b** of the cam base body **251** and the cam frame **253** is fit to the

sliding portion **251c**, one end of coil spring **254** is hooked to the spring hooking portion **252c** of the cam frame **252** and another end is hooked to the spring hooking portion **253c** of the cam frame **253**.

Then the coil spring **254** presses the cam frame **252** and **253** in a direction of approaching each other so that the flange portion **252b** advances until it strikes the stepped portion **251g** as the cam frame **252** slides the sliding portion **251b**. With this state, the first cam groove is formed by the one cam plane **40a** and the other cam plane **40b**.

Likewise, the cam frame **253** slides the sliding portion **251c** and the flange portion **253b** advances until it strikes the stepped portion **251h** so that the second cam groove is formed by the one cam plane **41a** and the other cam plane **41b** with this state.

Thus formed cam grooves **40, 41** become spring shaped cam grooves matched with movement of the first and second lens groups **21, 22** necessary to zooming.

As shown in Fig. 29, in the cam for zooming **25** configured as described above, the cam pin **21c** of the first lens group **21** is inserted into the cam groove **40** and the cam pin **22c** of the second lens group **22** is inserted into the cam groove **41**. By the insertion of the cam pins **21c, 22c** like this way, the flange portion **252b** of the cam frame **252** retreats a little from the stepped portion **251g** and likewise, the flange portion **253b** of the cam frame **253** retreats a little from the stepped portion **251h**.

Therefore, since the cam pin **21c** is pressed to the cam plane **40b** of the cam frame **252** and the cam pin **22c** is pressed to the cam plane **41b** of the cam frame **253**, the cam pins **21c, 22c** contact to the cam plane with a definite contact pressure over the whole region of the cam grooves **40, 41**. A contact pressure of the cam pins **21c, 22c** to the cam plane can be determined by a tensile force of the coil spring **254**. A most appropriate contact pressure of the cam pins **21c, 22c** is available when the coil spring **254** having an appropriate tensile force is chosen.

Thus, the cam for zooming **25** can be rotated with a definite motor driving force and the first

and the second lens groups **21**, **22** can be smoothly driven for moving. As a result, the cam for zooming **25** becomes a cam apparatus having a light load of small fluctuation so that a small and power-saving motor can be used as a motor for zooming **26**.

Fig. 18 is a cross sectional drawing showing a cross section of the cam for zooming **25** and its driving system by cutting by the A-A line of Fig. 28.

As shown in the drawing, a cam for zooming **25** of this second embodiment is explained. An inner gear **42** is provided at a rear end side of the cam for zooming **25**. A protruded portion 42a of the inner gear is inserted into an inner hole of the cam base body **251**. A key **42b** provided at a circumferential portion of the protruded portion **42a** fits in a key groove **251i** formed in a inner hole portion of the cam base body **251**.

Accordingly, the cam for zooming **25** rotates together with the inner gear **42**.

The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**.

The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

In the driving mechanism for zooming 20 exerted as above, the cam pins **21c**, **22c** exert a definite contact pressure over the whole region of the first and second cam groove **40**, **41**; the width in a lateral direction of the camera (width in a direction of left and right in Fig. 28) can be shortened in addition; and further the first and second lens groups **21**, **22** for zooming and the third lens group **31** are movably supported with the same guide shafts **23** so that the lens groups are difficult to fall or become eccentric.

Fig. 19 shows a driving mechanism for zooming **50** of the second embodiment.

The driving mechanism for zooming **50** is characterized in that the other cam planes **40b**, **41b** formed on the cam frames **252**, **253** are slanted at an predetermined angle, though, other features are the same as the driving mechanism for zooming **20** shown in Fig. 27-28.

Fig. 19 corresponds to a cross sectional view by the b-b line in Fig. 28.

Fig. 20 is a partially enlarged cross sectional drawing showing a configured portion formed by the first and second cam grooves **40**, **41** together with the cam pins **21c**, **22c**. As seen in the drawing, the other cam planes of the first and second cam frames **252**, **253** are formed as slanting cam planes having a rising gradient to the periphery of the frame.

The cam pins **21c**, **22c** receive a pushing force in a direction of **F1** shown in the drawing because the other cam planes **40b**, **41b** are formed as slanting planes. That is, as a spring force in a direction of **F2** shown in the drawing is exerted to the first and second cam fames **252**, **253** with the coil spring **254**, the first and second cam fames receive a pressing force **F1** in a direction orthogonal to the rotational axis of the cam groove in addition to the contact pressure of the cam pins **21c**, **22c** pressed by a slanting plane of the other cam planes **40b**, **41b** to the one cam plane **40a**, **41a**.

The above mentioned pressing force **F1** which acts on the cam pins affects in such a manner that hole plane portions of supporting holes **21d**, **22d** of the bosses **21b**, **22b** contacts the guide shaft **23** so as to absorb mechanical play between the supporting shaft holes **21d**, **22d** and the guide shaft **23**.

In the cam for zooming **25** as configured above, the cam pins **21c**, **22c** contact a whole region of the first and second cam grooves **40**, **41** with a definite contact pressure and are driven to move in a direction of the rotational axis of the cam groove according to rotation of the cam for zooming **25** so that the first and second lens groups **21**, **22** move along the guide shaft **23**.

Further, since the bosses **21b**, **22b** slide the guide shaft **23** without mechanical play as mentioned above, the second lens groups **21**, **22** do not become slanting or eccentric. As a result, the driving mechanism for zooming has a cam for zooming **25** (cam apparatus) capable of upgrading zooming accuracy.

Fig. 21 (A), (B), (C) are cross sectional drawings showing other embodiments similar to Fig. 20 wherein a slanted position of the cam plane of the first and second cam grooves **40**, **41**. Fig. 21

(A) is a cross sectional drawing showing one cam planes **40a**, **41a** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (B) is a cross sectional drawing showing one cam planes **40a, 41a** and other cam planes **40b, 41b** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (C) is a cross sectional drawing showing other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41** and cam pins **21c**, **22c**, which are formed slantingly.

Since a pressing force **F1** acts to the cam pins **21c**, **22c** in the event of the above configuration, play between the bosses **21b**, **22b** and the guide shaft **23** can be absorbed similarly to the embodiment shown in Fig. 20 so that slant or eccentricity of the first and second lens groups **21**, **22** can be prevented.

Further, when the both cam planes are formed slantingly as shown in Fig. 21 (B), smoother zooming action can be realized compared to the one with one slanted cam plane.

Also in the embodiment shown in Fig. 20, Fig. 21 (A), (B), the contact portion of the cam pins **21c**, **22c**, which contact the cam plane may be formed slantingly.

Fig. 22 shows another embodiment of a driving mechanism using a cam for zooming **25** of this third embodiment. Fig. 22 shows a driving mechanism in which a coil spring **45** is provided at a bearing portion **27a** of a front fixing frame **27** in order to absorb a bearing play of the cam for zooming **25**. The coil spring **45** enhances an accuracy of the moving position of the first and second lens groups **21**, **22** preventing from movement of the cam for zooming **25** in a direction of the rotational axis by pressing the cam for zooming **25** in one direction.

Fig. 23 shows an embodiment wherein a bearing play of the cam for zooming **25** and first and second cam frames **252**, **253** is pressed with a coil spring 46 by providing a coil spring **46** at a bearing part **27a** of a front fixing frame **27**.

This embodiment is configured in such a manner that a cam base body **251** is pressed through a cam pin **21c** by pressing a first cam frame **252** and a second cam frame **253** is pressed in one direction through a cam pin **22c**. With this configuration, a coil spring **254** hooked between the

cam frames **252** and **253** becomes unnecessary.

Fig. 32-34 show a zooming mechanism similar to the zooming mechanism **20** or **50** described above for a lens barrel less electronic camera (digital camera) having no lens barrel as an example.

Fig. 32 is a camera plan view. Fig. 33 is a camera front elevational view. Fig. 34 is a camera rear elevation view of an electronic camera shown in Fig. 32.

As shown in the drawings, the electronic camera has a form having a big longitudinal and transversal width and a small depth in a front view so that the camera is thin.

The electronic camera has two separate box-like bodies as a camera main body **60** provided with a controller, a memory card, a computing part, a memory card slot and others and as an optical system installed part **61** provided with a photographic lens and others.

And the camera main body **60** is rotatably within reasonable bounds coupled with the optical system installed part 61 by a coupling part **62**.

As shown in the drawing, on the upper plane of the camera main body **60**, a shutter button and a power switch are provided; on the back plane of the camera main body **60**, a liquid crystal monitor **65**, selection and decision button **66**, a zoom button **67**, mode selecting button **68** and others are provided; further, various circuit boards including a CPU, a battery which supplies electric power, a memory card slot are installed in the camera main body **60**(unshown).

Further, a photographic lens window **69** and a flash window of a flash unit **70** are provided on the upper plane of the optical system installed part **61**,and a zooming mechanism part **20, 50, 90** and a flash unit **80** stated later are installed by shielding light in the optical system installed part **61**.

Thus, while disposing a display unit, an operation unit, a battery, a memory card slot, and a circuit board in the camera main body **60**, thin shape of the whole camera is realized by integrating an optical mechanism and the flash unit **80** in the optical system installed part **61**.

Since the above mentioned electronic camera is a very thin type of camera, it is convenient to carry.

On the other hand, when taking a photograph, as shown in Fig. 35 for example, the optical system installed part **61** is rotated so that the photographic lens window **69** points at the front.

Since the camera main body **60** is grasped by hand and the shutter can be released in this state, the camera shake scarcely occurs with this camera.

Moreover, as the optical system installed part **61** can be rotated to an opposite side to that shown in Fig. 35, it can be pointed at the same direction as the liquid crystal monitor **65** for photographing.

Fig. 36 is a perspective illustration of an optical system installed part **61** when a rear case is removed. Fig. 37 is a transverse sectional view of the above optical system installed part. Fig. 38 is an exploded perspective illustration of the above optical system installed part **61**.

As seen in these drawings, the optical system installed part **61** has a flash unit **80** and a driving mechanism for zooming (a optical system unit) **90** of photographic lenses mounted in a box like front case (camera case) **71** so as to be a lens barrel less type having no lens barrel. The above units and others are installed by shielding light.

Therefore, the optical system installed part **61** is restricted to a thickness defined by a height of the optical unit which formed thin so that a thin type of camera is realized.

The flash unit **80** resides in the innermost portion of the flash part **81** and the front case **71** and has a main condenser **82** disposed adjacently at the rear of the optical system unit and a circuit board **83** at the side of the optical system unit in the front case **71**.

The driving mechanism for zooming **90** is disposed in the frond case **71** by screwing with small screws **91**. A photographing image light enters in an image capturing optical system consisting of the first, second and third lens groups **21**, **22**, **31** through the photographic lens window **69**.

In addition, the cover **92** which prevents invasion of solder waste, dust, and others is provided on the driving mechanism for zooming **90**.

As mentioned above, the rear case **72** is fixed with a screw to the front case **71** to which the flash unit **80** and driving mechanism for zooming **90** are mounted.

More particularly, as shown in Fig. 38, the rear case **72** is fixed to the front case **71** with the small screw **93** which is inserted into the one side of the rear case **72** from the front case **71**. The other side of the rear case **72** is screwed with the one side of a tongue flange **62a** of the coupling part **62**.

That is, the one side of the tongue flange **62** of the coupling part **62** is fixed with a small screw **73** to the front case **71** and rear case **72** so as to unite together.

In addition, the other side of the tongue flange **62b** of the coupling part **62** is screwed to the case of the camera main body **60**, with a tubular portion **62c** of which the camera main body **60** couples rotatably with the optical system installed part **61** and through the tubular portion, two parts are electrically connected with wire.

Further, **94** shown in Fig. 38 is a cam pushing pin; **95** is a cam spring; and **96** is a image capturing unit; these are described later.

The above optical system installed part **61** is unnecessary to provide a lense barrel and can be made with a depth fit to the lens diameter so as to be appropriate to a very thin type electronic camera.

Fig. 39 is a perspective illustration of the driving mechanism for zooming **90**.

This driving mechanism for zooming **90** has a configuration similar to the driving mechanism for zooming **20** or **50**. Only what is different in this driving mechanism for zooming is that the cam for zooming **25** is disposed at the left side of the photographic lens groups and the motor for zooming **26** is disposed in front, the motor for focusing is disposed in rear.

A thinner camera than a camera in which two motors are disposed as overlapped can be obtained in this way by disposing the motor for zooming **26** and the motor for focusing **33** separately at front side and rear side. Further, electro magnetic interference between two motors can be avoided.

As for a cam for zooming **25**, as shown in Fig. 40, a cam base body **251** is formed from two cylinder type base bodies **351**, **352**. More particularly, an inserting shaft portion **351a** of the cylinder type base body **351** is inserted into a cylinder type base body **352** and an eccentric pin **74** is inserted through a hole portion **352a** of the cylinder type base body **352** to fix to a pin hole of the inserting shaft portion **351a** so that these cylinder type base bodies **351**, **352** are combined together. That is, the distance between the one cam plane **40a** formed on the cylinder type base body **351** and the one cam plane **41a** formed on the cylinder type base body **352** is finely adjusted by rotating the eccentric pin **74** for adjusting an inserted depth of the inserting shaft portion **351a**.

In addition, as already stated above, the first and second cam groove **40, 41** are formed by the one cam planes **40a, 41a** and the other cam planes **40b, 41b** of the cam frame **252**, **253**.

Meanwhile, a pin receiving umbo **252e** is projectingly formed toward the inner portion on the cam frame **252** of the cam for zooming **25** so as to slide in a long hole **351c** of the cylinder type base body 351. The cam frame **252, 253** and the cam base body **251** are pressed in one direction by pressing the pin receiving umbo **252e** with the cam pressing pin **94**.

As shown in Fig. 37, the cam pressing pin **94** is inserted through a hole **27c** of a front fixing frame **27** and its tip is contacted to the pin receiving umbo **252e**. Pressing force is given to the cam pressing pin **94** by a cam spring **95** provided in the above hole **27c**. The cam pressing pin **94** and the cam spring **95** are prevented to come off with a plate extended from the flash part **81**.

In the cam for zooming **25**, the cam frame **253** rotates together with the cylinder type base body **352** by fitting a protruded portion of a key provided in it to a key groove **352b**.

Also provided is the cam frame **252** with an interlocking gear **75** which is driven through a rate reducing device **44** with a motor.

The rate reducing device **44** of the driving mechanism for zooming **90** is, as shown in Fig. 41,

comprises a front gear group and a rear gear group. The front gear group comprises a gear **44b** a large diameter gear portion of which is engaged with a pinion **44a** of the motor for zooming **26** and a gear **44c** which is engaged with a small diameter gear portion of the gear **44b**.
In addition, a gear **44c** is provided at the front end of a rotational axis rod **44d** through which the rear gear group is interlocked.

The rear gear group comprises a gear **44e** provided at the rear end of the rotational axis rod **44d**, a gear **44f** a large diameter gear portion of which engages the gear **44e**, and a gear **44g** a large diameter gear portion of which engages a small diameter gear portion of the gear **44f**. An interlocking gear **75** of the cam frame **253** engages the small diameter gear portion of the gear **44g**.

Since gear groups comprises the front gear group and the rear gear group, a place for the rate reducing gear is divided into two, the rate reducing device **44** can be fit with the photographic lens diameter so as to be appropriate for making a thin optical system absorption part **61**.

To explain more particularly, in order to secure an enough rate reducing ratio for disposing a whole reducing gears in one place, a rate reducing gear group needs to be extendedly disposed in a direction of zooming of the mechanism for zooming, which leads to a long mechanism for zooming to prevent miniaturization.

Also in order to secure an enough rate reducing ratio without changing a length, the gear needs to be big in diameter so that a rate reducing device fit to a diameter of the lens can not be realized, which result in preventing miniaturization.

Fig. 11 is an exploded perspective view of an image capturing unit **96**. The image capturing unit 96 comprises a holder **354**, a mask **353**, a filter (LPF) **352**, a rubber **351**, a CCD **320**, a plate **355** and a circuit board **358**. More particularly, the image capturing unit **96** is configured in such a manner that the mask **353**, the filter **352**, the rubber **351** and the CCD are disposed between the holder **354** and the plate **355**, the holder **354** is fixed to the plate with a small screw **356** to form one unit, after that the CCD **320** is electrically connected to the circuit board **358**, and the circuit board **358** is fixed.

The image capturing unit **96** made in this way is fixed to the rear fixing frame **28** of the driving mechanism for zooming **90** as shown in Fig. 42, 43.

More particularly, the rear fixing frame **28** has a standard plane **28b** and a fixing prong **28c** and leaf springs **105**, **106** which hold the image capturing unit **96** are attached to the rear fixing frame **28**.

Therefore, when flange portions of the plate **355** are inserted between the standard plane **258b** and the leaf springs **105**, **106**, the one fixing prong **28c** plunges in a fixing hole **102a** of the plate **355** and the other fixing prong **28c** catches a fixing groove **102b** of the plate **355** so that the image capturing unit **96** is fixed by the elastic holding force of the two leaf springs **105**, **106**.

Though Fig. 42, 43 shows a state in which the circuit board **358** is taken off, the image capturing unit **96** is actually attached as shown in Fig. 44.

According to this embodiment, there is proposed a camera having a zooming function comprising a camera main body part provided with a display unit and an operation unit, an optical system unit having
a lens barrel less lens mechanism part with a zoom lens and a focus lens, and a driving mechanism part in which a zoom lens driving mechanism and a focus lens driving mechanism are built integrally, an optical system installed part by shielding light, and an coupling part which rotataboly couples the camera main body with the optical system installed part, wherein the camera main body part and the operation unit are formed as thin box-like bodies of the approximately same thickness.

Further, according to this embodiment, a camera is proposed wherein a thickness of the camera main body and a thickness of the optical system installed part are restricted to a height of the optical system unit.

Further, according to this embodiment, a camera is proposed wherein a flash unit comprising a

main condenser, a circuit board and flash part is installed in the optical system installed part.

Further, according to this embodiment, a camera is proposed wherein a circuit board is disposed adjacently to a side of the optical system unit and a main condenser is disposed adjacently to a back of the optical system unit.

Further according to this embodiment a camera is proposed, which comprises a lens frame of the zooming lens and a lens frame of the focusing lens wherein the camera the guide shaft guides the lens frame of the zooming lens together with the lens frame of the focusing lens the in any one of the above cameras.

Further according to this embodiment, a camera is proposed wherein a image capturing unit having an image capturing element and a rear fixing frame are provided thereto and the image capturing unit is directly attached to the rear fixing frame in the aforementioned camera.

As described above, since the camera according to this embodiment is provided with an optical unit comprising integrally a lens mechanism part having at least a zooming lens and a focusing lens together with a driving mechanism part of the zooming lens and focusing lens wherein the optical unit is installed in a camera case provided with a photographic lens window, a camera form can be made thin so as to fit with a lens diameter. As a result, it is possible to offer a very thin camera having a zooming function.

Sixth Embodiment

Though it is advantageous to fix an image capturing element with a screw in terms of sure fixing, deflection by screw fixing generates in case of a miniaturized lens barrel, which affects a mechanical structure and an optical system.

In view of the above situation, according to this embodiment, an image capturing apparatus and a camera are proposed wherein fixing problem does not affect mechanically and optically

even in the event of an optical system unit of a thin electronic camera or a miniaturized lens barrel.

With reference to accompanying drawings, a fifth embodiment according to the present invention when executed in an electronic camera is described as follows.

Fig. 27 is a perspective illustration showing a driving mechanism for zooming **20** of a photographic lens. Fig. 28 is a front elevational view of the above driving mechanism for zooming **20**.

In the drawings, **21** is a first lens group, **22** is a second lens group. The first and second lens groups are supported by a guide shaft **23** which is pierced so as to be able to slide to a boss **21b** provided on a lens frame **21a** and boss **22b** provided on a lens frame **22a**.

Holes are provided at the opposite position to the bosses **21b**, **22b** on the lens frames **21a**, **22a** and a guide shaft **24** is pierced to these holes so as to be able to slide to prevent rotation of the lens groups **21**, **22**.

Further, a cam pin (a cam groove inserting member) **21c** of the first lens group **21** formed projectingly on the above boss **21b** and a cam pin (a cam groove inserting member) **22c** of the second lens group **22** formed projectingly on the boss **22b** are inserted into the cam groove of the cam for zooming **25** so that the first and second lens groups are cam-driven along the optical axis according to rotation of the cam for zooming **25**(see Fig. 29). The cam for zooming **25** is rotatively driven by a motor for zooming **26**

One end of the guide shaft **23**, **24** is fixed to a front fixing frame **27** and another end is fixed to a rear fixing frame **28**. The cam for zooming **25** is rotatably supported by a bearing portion **27a** of the front fixing frame **27** and a bearing portion **29a** (see Fig. 18) of a supporting fixing frame **29** fixed to the rear fixing frame **28**.

Window holes **27b**, **28a** through which object image light passes are formed on the front fixing

frame **27** and the rear fixing frame **28**. Further, a CCD (an solid image forming element) is mounted in right after the window of the rear fixing frame **28** (see Fig. **27**, **29**).

While, a third lens group 31 shown in Fig. **27** is a lens for focusing and is supported by piercing the guide shaft **23** to a boss **31a** provided on the lens frame **31a**. The third lens group **31** is screw-driven by a lead screw **34** rotatively driven with a motor for focusing **33** to advance and retreat along the optical axis.

Besides, referring to Fig. 27, **35** is a shutter unit fixed to the lens frame **22a**; **36** is a cover plate; **37** is a photo interrupter for zooming; **38** is a photo interrupter for focusing; and **39** is a spring for preventing a play of the third lens group **31**, the spring which presses the boss in one direction to absorb the play between the lead screw **34** and a nut **32**. The photo interrupter for zooming **37** detects an initial position for zooming and the photo interrupter for focusing detects an initial position for focusing.

In the above configured driving mechanism for zooming of the photographic lens, the first and second lens group **21**, **22** moves for zooming by driving rotatively the cam for zooming **25** with the motor for zooming **26** and the third lens group **31** moves for focusing by driving rotatively the lead screw **34** to screw-drive the nut screw **32**.

In addition, the third lens group **31** moves also at the time of zooming.

The cam **25** for zoom with which the above mentioned driving mechanism for zooming **20** is equipped as a cam apparatus on the other hand is explained with reference to Fig. 29, Fig. 30, and Fig. 31.

Fig. 29 is the same perspective illustration of a cam for zooming as Fig. 1 when the third lens group, the motor for focusing **33**, the shutter unit **35**, the cover plate **36** and so on are removed for showing. Fig. 30 is a perspective illustration of a cam for zooming **25**. Fig. 31 is an exploded perspective illustration of a cam for zooming.

As shown in the drawing, the cam **25** for zooming is a cylindrical cam having a first cam groove **40** and a second cam groove **41** and comprises a cylindrical cam base body **251**,

cylindrical cam frames **252**, **253** which fit the both sides of the cam base body **251** so as to be able to slide, and a tensile coil spring **254** pressing the cam frames **252**, **253** in a direction for approaching each other.

A cam base body **251** has a sliding portions **251b**, **251c** having a smaller portion at the both sides of the middle portion **251a**. One cam plane **40a** is formed for forming a first cam groove **40** at a stepped portion between the middle portion **251a** and the sliding portion **251b**. One cam plane **41a** is formed for forming a first cam groove **41** at a stepped portion between the middle portion **251a** and the sliding portion **251c**.

The cam base body **251** has long holes **251d**, **251e** along an axial direction from the both ends, into which protruded portions **252a**, **253a** are fit so as to be able to slide, whereby the cam frames **252**, **253** are rotated together with the cam base body **251**. A hole portion **251f** formed at the ends of sliding portion **251b**, **251c** is to attach a coil spring **254**. Stepped portions **251g**, **251h** are to restrict movement of a cam frame **252**, **253**.

Meanwhile, a cam frame **252** has another cam plane **40b** for forming a first cam groove **40** at one end circumference portion and further has a pointing inner flange **252b**. The cam frame **252** has a spring hooking portion **252c** projected from the protruded portion **252a** in the cylinder.

A cam frame **253** has another cam plane **41b** for forming a first cam groove **41** at one end circumference portion and further has a pointing inner flange **253b**. The cam frame **253** has a spring hooking portion **253c** projected from the protruded portion **253a** in the cylinder.

With regard to the cam base body **251**, the cam frames **252**, and **253**, after the cam frame **252** is fit to the sliding portion **251b** of the cam base body **251** and the cam frame **253** is fit to the sliding portion **251c**, one end of coil spring **254** is hooked to the spring hooking portion **252c** of the cam frame **252** and another end is hooked to the spring hooking portion **253c** of the cam frame **253**.

Then the coil spring **254** presses the cam frame **252** and **253** in a direction of approaching each

other so that the flange portion **252b** advances until it strikes the stepped portion **251g** as the cam frame **252** slides the sliding portion **251b**. With this state, the first cam groove is formed by the one cam plane **40a** and the other cam plane **40b**.

Likewise, the cam frame **253** slides the sliding portion **251c** and the flange portion **253b** advances until it strikes the stepped portion **251h** so that the second cam groove is formed by the one cam plane **41a** and the other cam plane **41b** with this state.

Thus formed cam grooves **40**, **41** become spring shaped cam grooves matched with movement of the first and second lens groups **21**, **22** necessary to zooming.

As shown in Fig. 29, in the cam for zooming 25 configured as described above, the cam pin **21c** of the first lens group **21** is inserted into the cam groove **40** and the cam pin **22c** of the second lens group **22** is inserted into the cam groove **41**. By the insertion of the cam pins 21c, 22c like this way, the flange portion **252b** of the cam frame **252** retreats a little from the stepped portion **251g** and likewise, the flange portion **253b** of the cam frame **253** retreats a little from the stepped portion **251h**.

Therefore, since the cam pin **21c** is pressed to the cam plane **40b** of the cam frame **252** and the cam pin **22c** is pressed to the cam plane **41b** of the cam frame **253**, the cam pins **21c**, **22c** contact to the cam plane with a definite contact pressure over the whole region of the cam grooves **40**, **41**. A contact pressure of the cam pins **21c**, **22c** to the cam plane can be determined by a tensile force of the coil spring **254**. A most appropriate contact pressure of the cam pins **21c**, **22c** is available when the coil spring **254** having an appropriate tensile force is chosen.

Thus, the cam for zooming **25** can be rotated with a definite motor driving force and the first and the second lens groups **21**, **22** can be smoothly driven for moving. As a result, the cam for zooming **25** becomes a cam apparatus having a light load of small fluctuation so that a small and power-saving motor can be used as a motor for zooming **26**.

Fig. 18 is a cross sectional drawing showing a cross section of the cam for zooming 25 and its

driving system by cutting by the A-A line of Fig. 28.

As shown in the drawing, a cam for zooming **25** of this second embodiment is explained. An inner gear **42** is provided at a rear end side of the cam for zooming **25**. A protruded portion 42a of the inner gear is inserted into an inner hole of the cam base body **251**. A key **42b** provided at a circumferential portion of the protruded portion **42a** fits in a key groove **251i** formed in a inner hole portion of the cam base body **251**.

Accordingly, the cam for zooming **25** rotates together with the inner gear **42**.

The inner gear **42** is rotatably supported by a bearing portion **29a** provided on a supporting fixing frame **29** and further engages a small coupling gear **43**.

The small coupling gear **43**, which is driven by the motor for zooming **26** through a rate reducing device **44**, rotates the inner gear **42** to rotate the cam for zooming **25**.

In the driving mechanism for zooming **20** exerted as above, the cam pins **21c**, **22c** exert a definite contact pressure over the whole region of the first and second cam groove **40**, **41**; the width in a lateral direction of the camera (width in a direction of left and right in Fig. 28) can be shortened in addition; and further the first and second lens groups **21**, **22** for zooming and the third lens group **31** are movably supported with the same guide shafts **23** so that the lens groups are difficult to fall or become eccentric.

Fig. 19 shows a driving mechanism for zooming **50** of the second embodiment.

The driving mechanism for zooming **50** is characterized in that the other cam planes **40b, 41b** formed on the cam frames **252, 253** are slanted at an predetermined angle, though, other features are the same as the driving mechanism for zooming **20** shown in Fig. 27-28.

Fig. 19 corresponds to a cross sectional view by the b-b line in Fig. 28.

Fig. 20 is a partially enlarged cross sectional drawing showing a configured portion formed by the first and second cam grooves **40**, **41** together with the cam pins **21c**, **22c**. As seen in the drawing, the other cam planes of the first and second cam frames **252, 253** are formed as slanting cam planes having a rising gradient to the periphery of the frame.

The cam pins **21c**, **22c** receive a pushing force in a direction of **F1** shown in the drawing because the other cam planes **40b**, **41b** are formed as slanting planes. That is, as a spring force in a direction of **F2** shown in the drawing is exerted to the first and second cam fames **252**, **253** with the coil spring **254**, the first and second cam fames receive a pressing force **F1** in a direction orthogonal to the rotational axis of the cam groove in addition to the contact pressure of the cam pins **21c**, **22c** pressed by a slanting plane of the other cam planes **40b**, **41b** to the one cam plane **40a**, **41a**.

The above mentioned pressing force **F1** which acts on the cam pins affects in such a manner that hole plane portions of supporting holes **21d**, **22d** of the bosses **21b**, **22b** contacts the guide shaft **23** so as to absorb mechanical play between the supporting shaft holes **21d**, **22d** and the guide shaft **23**.

In the cam for zooming **25** as configured above, the cam pins **21c**, **22c** contact a whole region of the first and second cam grooves **40**, **41** with a definite contact pressure and are driven to move in a direction of the rotational axis of the cam groove according to rotation of the cam for zooming **25** so that the first and second lens groups **21**, **22** move along the guide shaft **23**.

Further, since the bosses **21b**, **22b** slide the guide shaft **23** without mechanical play as mentioned above, the second lens groups **21**, **22** do not become slanting or eccentric. As a result, the driving mechanism for zooming has a cam for zooming **25** (cam apparatus) capable of upgrading zooming accuracy.

Fig. 21 (A), (B), (C) are cross sectional drawings showing other embodiments similar to Fig. 20 wherein a slanted position of the cam plane of the first and second cam grooves **40**, **41**. Fig. 21 (A) is a cross sectional drawing showing one cam planes **40a**, **41a** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (B) is a cross sectional drawing showing one cam planes **40a**, **41a** and other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41**, which are formed slantingly. Fig. 21 (C) is a cross sectional drawing showing other cam planes **40b**, **41b** of the first and second cam grooves **40**, **41** and cam pins **21c**, **22c**, which are

formed slantingly.

Since a pressing force **F1** acts to the cam pins **21c**, **22c** in the event of the above configuration, play between the bosses **21b**, **22b** and the guide shaft **23** can be absorbed similarly to the embodiment shown in Fig. 20 so that slant or eccentricity of the first and second lens groups **21**, **22** can be prevented.

Further, when the both cam planes are formed slantingly as shown in Fig. 21 (B), smoother zooming action can be realized compared to the one with one slanted cam plane.

Also in the embodiment shown in Fig. 20, Fig. 21 (A), (B), the contact portion of the cam pins **21c**, **22c**, which contact the cam plane may be formed slantingly.

Fig. 22 shows another embodiment of a driving mechanism using a cam for zooming **25** of this third embodiment. Fig. 22 shows a driving mechanism in which a coil spring **45** is provided at a bearing portion **27a** of a front fixing frame **27** in order to absorb a bearing play of the cam for zooming **25**. The coil spring **45** enhances an accuracy of the moving position of the first and second lens groups **21**, **22** preventing from movement of the cam for zooming **25** in a direction of the rotational axis by pressing the cam for zooming **25** in one direction.

Fig. 23 shows an embodiment wherein a bearing play of the cam for zooming **25** and first and second cam frames **252**, **253** is pressed with a coil spring 46 by providing a coil spring **46** at a bearing part **27a** of a front fixing frame **27**.

This embodiment is configured in such a manner that a cam base body **251** is pressed through a cam pin **21c** by pressing a first cam frame **252** and a second cam frame **253** is pressed in one direction through a cam pin **22c**. With this configuration, a coil spring **254** hooked between the cam frames **252** and **253** becomes unnecessary.

Fig. 32-34 show a zooming mechanism similar to the zooming mechanism **20** or **50** described above for a lens-barrel-less electronic camera (digital camera) having no lens barrel as an example.

Fig. 32 is a camera plan view. Fig. 33 is a camera front elevational view. Fig. 34 is a camera rear elevation view of an electronic camera shown in Fig. 32.

As shown in the drawings, the electronic camera has a form having a big longitudinal and transversal width and a small depth in a front view so that the camera is thin.

The electronic camera has two separate box-like bodies as a camera main body 60 provided with a controller, a memory card, a computing part, a memory card slot and others and as an optical system installed part 61 provided with a photographic lens and others.

And the camera main body 60 is rotatably within reasonable bounds coupled with the optical system installed part 61 by a coupling part 62.

As shown in the drawing, on the upper plane of the camera main body **60**, a shutter button and a power switch are provided; on the back plane of the camera main body **60**, a liquid crystal monitor **65**, selection and decision button **66**, a zoom button **67**, mode selecting button **68** and others are provided; further, various circuit boards including a CPU, a battery which supplies electric power, a memory card slot are installed in the camera main body **60**(unshown).

Further, a photographic lens window **69** and a flash window of a flash unit **70** are provided on the upper plane of the optical system installed part **61**,and a zooming mechanism part **20**, **50**, **90** and a flash unit **80** stated later are installed by shielding light in the optical system installed part **61**.

Thus, while disposing a display unit, an operation unit, a battery, a memory card slot, and a circuit board in the camera main body **60**, thin shape of the whole camera is realized by integrating an optical mechanism and the flash unit **80** in the optical system installed part **61**.

Since the above mentioned electronic camera is a very thin type of camera, it is convenient to carry.

On the other hand, when taking a photograph, as shown in Fig. 35 for example, the optical system installed part **61** is rotated so that the photographic lens window **69** points at the front.

Since the camera main body **60** is grasped by hand and the shutter can be released in this state, the camera shake scarcely occurs with this camera.

Moreover, as the optical system installed part **61** can be rotated to an opposite side to that shown in Fig. 35, it can be pointed at the same direction as the liquid crystal monitor **65** for photographing.

Fig. 36 is a perspective illustration of an optical system installed part **61** when a rear case is removed. Fig. 37 is a transverse sectional view of the above optical system installed part. Fig. 38 is an exploded perspective illustration of the above optical system installed part **61**.

As seen in these drawings, the optical system installed part **61** has a flash unit **80** and a driving mechanism for zooming (a optical system unit) **90** of photographic lenses mounted in a box like front case (camera case) **71** so as to be a lens barrel less type having no lens barrel. The above units and others are installed by shielding light.

Therefore, the optical system installed part **61** is restricted to a thickness defined by a height of the optical unit which formed thin so that a thin type of camera is realized.

The flash unit **80** resides in the innermost portion of the flash part **81** and the front case **71** and has a main condenser **82** disposed adjacently at the rear of the optical system unit and a circuit board **83** at the side of the optical system unit in the front case **71**.

The driving mechanism for zooming **90** is disposed in the frond case **71** by screwing with small screws **91**. A photographing image light enters in an image capturing optical system consisting of the first, second and third lens groups **21, 22, 31** through the photographic lens window **69**.

In addition, the cover **92** which prevents invasion of solder waste, dust, and others is provided on the driving mechanism for zooming **90**.

As mentioned above, the rear case **72** is fixed with a screw to the front case **71** to which the flash unit **80** and driving mechanism for zooming **90** are mounted.

More particularly, as shown in Fig. 38, the rear case **72** is fixed to the front case **71** with the small screw **93** which is inserted into the one side of the rear case **72** from the front case **71**. The

other side of the rear case **72** is screwed with the one side of a tongue flange **62a** of the coupling part **62**.

That is, the one side of the tongue flange **62** of the coupling part **62** is fixed with a small screw **73** to the front case **71** and rear case **72** so as to unite together.

In addition, the other side of the tongue flange **62b** of the coupling part **62** is screwed to the case of the camera main body **60**, with a tubular portion **62c** of which the camera main body **60** couples rotatably with the optical system installed part **61** and through the tubular portion, two parts are electrically connected with wire.

Further, **94** shown in Fig. 38 is a cam pushing pin; **95** is a cam spring; and **96** is a image capturing unit; these are described later.

The above optical system installed part **61** is unnecessary to provide a lenses barrel and can be made with a depth fit to the lens diameter so as to be appropriate to a very thin type electronic camera.

Fig. 39 is a perspective illustration of the driving mechanism for zooming **90**.

This driving mechanism for zooming **90** has a configuration similar to the driving mechanism for zooming **20** or **50**. Only what is different in this driving mechanism for zooming is that the cam for zooming **25** is disposed at the left side of the photographic lens groups and the motor for zooming **26** is disposed in front, the motor for focusing is disposed in rear.

A thinner camera than a camera in which two motors are disposed as overlapped can be obtained in this way by disposing the motor for zooming **26** and the motor for focusing **33** separately at front side and rear side. Further, electro magnetic interference between two motors can be avoided.

As for a cam for zooming **25**, as shown in Fig. 40, a cam base body **251** is formed from two cylinder type base bodies **351**, **352**. More particularly, an inserting shaft portion **351a** of the cylinder type base body **351** is inserted into a cylinder type base body **352** and an eccentric pin **74** is inserted through a hole portion **352a** of the cylinder type base body **352** to fix to a pin hole

of the inserting shaft portion **351a** so that these cylinder type base bodies **351**, **352** are combined together. In addition, as already stated above, the first and second cam groove **40**, **41** are formed by the one cam planes **40a**, **41a** and the other cam planes **40b**, **41b** of the cam frame **252**, **253**.

Meanwhile, a pin receiving umbo **252e** is projectingly formed toward the inner portion on the cam frame **252** of the cam for zooming **25** so as to slide in a long hole **351c** of the cylinder type base body 351. The cam frame **252**, **253** and the cam base body **251** are pressed in one direction by pressing the pin receiving umbo **252e** with the cam pressing pin **94**.

As shown in Fig. 37, the cam pressing pin **94** is inserted through a hole **27c** of a front fixing frame **27** and its tip is contacted to the pin receiving umbo **252e**. Pressing force is given to the cam pressing pin **94** by a cam spring **95** provided in the above hole **27c**. The cam pressing pin **94** and the cam spring **95** are prevented to come off with a plate extended from the flash part **81**.

In the cam for zooming **25**, the cam frame **253** rotates together with the cylinder type base body **352** by fitting a protruded portion of a key provided in it to a key groove **352b**.

Also provided is the cam frame **252** with an interlocking gear **75** which is driven through a rate reducing device **44** with a motor.

The rate reducing device **44** of the driving mechanism for zooming **90** is, as shown in Fig. 41, comprises a front gear group and a rear gear group. The front gear group comprises a gear **44b** a large diameter gear portion of which is engaged with a pinion **44a** of the motor for zooming **26** and a gear **44c** which is engaged with a small diameter gear portion of the gear **44b**.

In addition, a gear **44c** is provided at the front end of a rotational axis rod **44d** through which the rear gear group is interlocked.

The rear gear group comprises a gear **44e** provided at the rear end of the rotational axis rod **44d**, a gear **44f** a large diameter gear portion of which engages the gear **44e**, and a gear **44g** a large diameter gear portion of which engages a small diameter gear portion of the gear **44f**. An interlocking gear **75** of the cam frame **253** engages the small diameter gear portion of the gear

44g.

Since gear groups comprises the front gear group and the rear gear group, a place for the rate reducing gear is divided into two, the rate reducing device **44** can be fit with the photographic lens diameter so as to be appropriate for making a thin optical system absorption part **61**.

To explain more particularly, in order to secure an enough rate reducing ratio for disposing a whole reducing gears in one place, a rate reducing gear group needs to be extendedly disposed in a direction of zooming of the mechanism for zooming, which leads to a long mechanism for zooming to prevent miniaturization.

Also in order to secure an enough rate reducing ratio without changing a length, the gear needs to be big in diameter so that a rate reducing device fit to a diameter of the lens can not be realized, which result in preventing miniaturization.

Fig. 11 is an exploded perspective view of an image capturing unit **96**. The image capturing unit 96 comprises a holder **354**, a mask **353**, a filter (LPF) **352**, a rubber **351**, a CCD **320**, a plate **355** and a circuit board **358**. More particularly, the image capturing unit **96** is configured in such a manner that the mask **353**, the filter **352**, the rubber **351** and the CCD are disposed between the holder **354** and the plate **355**, the holder **354** is fixed to the plate with a small screw **356** to form one unit, after that the CCD **320** is electrically connected to the circuit board **358**, and the circuit board **358** is fixed.

The image capturing unit **96** made in this way is fixed to the rear fixing frame **28** of the driving mechanism for zooming **90** as shown in Fig. 42, 43.

More particularly, the rear fixing frame **28** has a standard plane **28b** and a fixing prong **28c** and leaf springs **105**, **106** which hold the image capturing unit **96** are attached to the rear fixing frame **28**.

The standard plane 28b is formed on a fixing frame portion of an image focus location peripheral of photographic lenses (the first, second and third lens groups). The leaf springs 105, 106 can also be provided on the front case 71.

Therefore, when flange portions of the plate **355** are inserted between the standard plane **258b** and the leaf springs **105**, **106**, the one fixing prong **28c** plunges in a fixing hole **102a** of the plate **355** and the other fixing prong **28c** catches a fixing groove **102b** of the plate **355** so that the image capturing unit **96** is fixed by the extended flange portion of the plate 355 pressing the standard plane 28b with the elastic pressure of the two leaf springs **105**, **106**.

Though Fig. 42, 43 shows a state in which the circuit board **358** is taken off, the image capturing unit **96** is actually attached as shown in Fig. 44.

A photographing unit **96** is fixed by holding elastically with the leaf plates **105**, **106** so that distortion due to fixing with a screw to a fixing frame does not generate. Therefore, the CCD **101** (the image capturing element) can be attached without affecting mechanically or optically the driving mechanism for zooming.

When the CCD 101 is positioned by plunging one fixing prong 28c of the rear fixing frame 28 in a fixing hole 102a of the plate 355 and fitting the other fixing prong 28c in a fixing groove 102b of the plate 355, it can be fixed appropriately, coping with fluctuation of parts and assembling since the fixing groove 102b which catches the other fixing prong 28c is formed as a cut groove.

Further, the photographing unit 96 is configured as such that a mask 353, a filter 352, a rubber 351 and a CCD 320 are held by fixing a holder 354 together with a plate 355 with screws. Therefore, these members are tightly contacted each other with elasticity of the rubber 351 so that dust invading in a light acceptance surface of the CCD 320 can be perfectly prevented.

As a result, the photographing unit 96 is easily stored in control and easily treated in case of assembly.

According to this embodiment an image capturing apparatus is proposed, which comprises an image capturing element, a holding member which holds the image capturing element, a fixing frame having a standard plane to position the holding member, an elastic member disposed on

the fixing frame, wherein the image capturing element is positioned to the fixing frame by pressing the holding member on the standard plane with the elastic member.

In this image capturing apparatus, the holding member of the image capturing element is pressed with elasticity of the elastic member and the holding member contacts the standard plane by receiving its pressing force. As a result, the holding member of the image capturing element is sandwiched and held with the standard plane and the elastic member so that the image capturing element is rightly attached to a light acceptance position of the photographic lens.

According to this embodiment, in the above described image capturing apparatus, an image capturing apparatus is proposed, which further comprises a holder, a mask, a filter having an optical property of LPF and a rubber having elasticity wherein the image capturing element is held with the holding member by pinching the image capturing element, the rubber, the filter and the mask with the holding member and the holder.

In this image capturing apparatus, as the image capturing element is held with the rubber, the image capturing element, the filter and the mask are tightly contacted so that dust invasion to the light acceptance surface is prevented.

According to this embodiment, in the above described image capturing apparatus, an image capturing apparatus is proposed, which further comprises a circuit board which performs electrical connection with the image capturing element wherein the circuit board is combined with the holding member by disposing the circuit board in the rear of the holding member and soldering the circuit board to the image capturing element.
The image capturing apparatus is attached with a circuit board so as to become an image capturing unit.

According to this embodiment, in any one of the above described image capturing apparatuses, an image capturing apparatus is proposed, which further comprises flange portions provided at both ends of the holding member, each flange portion having a fixing hole for positioning, and a

fixing prong corresponding to the fixing hole provided in the vicinity of the standard plane, wherein the elastic member is a leaf spring provided corresponding to the fixing prong and the image capturing element is positioned and fixed on the fixing frame by fixing the fixing prong to the fixing hole and by pressing and fixing the flanged portion with the leaf spring.

The image capturing element of the image capturing apparatus of this embodiment is positioned by plunging the fixing prong provided on the fixing frame to the fixing hole provided on the extended flange portion of the holding member and the extended flange portion is fixed by pressing the leaf springs.

According to this embodiment a camera is proposed, which comprises a photographic lens, a frame part which holds the photographic lens, an image capturing element, a holding member which holds the image capturing element, a fixing frame disposed at the rear end portion of the frame part having a standard plane on which the holding member is positioned, and the elastic member disposed on the fixing frame, wherein the image capturing element is positioned and fixed on the fixing frame by pressing the holding member on the standard plane with the elastic member.

The camera of this embodiment have no mechanical or optical problem which arises by fixing with screw, because the holding member of the image capturing element is not fixed with screw.

According to this embodiment, in the above described camera, a camera is proposed, which further comprises a holder, a mask, a filter having an optical property of LPF and a rubber having elasticity wherein the image capturing element is held with the holding member by pinching the image capturing element, the rubber, the filter and the mask with the holding member and the holder.

According to this embodiment, in the above described camera, a camera is proposed, which further comprises a circuit board which performs electrical connection with the image capturing element wherein the circuit board is combined with the holding member by disposing the circuit

board in the rear of the holding member and soldering the circuit board to the image capturing element.

According to this embodiment, in any one of the above described camera, a camera is proposed, which further comprises flange portions provided at both ends of the holding member, each flange portion having a fixing hole for positioning, and a fixing prong corresponding to the fixing hole provided in the vicinity of the standard plane, wherein the elastic member is a leaf spring provided corresponding to the fixing prong and the image capturing element is positioned and fixed on the fixing frame by fixing the fixing prong to the fixing hole and by pressing and fixing the flanged portion with the leaf spring.

As described above, since an image capturing apparatus or a camera of this embodiment is configured in such a manner that a pressing force of the elastic member is given to the holding member of the image capturing element to press the holding member to the standard plane with the pressing force, the image capturing element is fixed by pinching the holding member with the standard plane and the elastic member.

As a result, the image capturing element can be fixed without mechanically or optically affecting the optical unit.

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